ErgoApps : A mobile application that create awareness and reminder on having ergonomic practices to avoid Work Related Musculoskeletal Disorders (WMSD).

By

Yusairah binti Hamzah

Final dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Technology (Hons)
(Information & Communication Technology)

JAN 2013

UniversitiTeknologi PETRONAS
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Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

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Approved by,

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(Assoc. Prof. Dr. Dayang Rohaya bt. Awang Rambli)

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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YUSAIRAH BINTI HAMZAH

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ABSTRACT

Occupational accidents and diseases keep consistently high and increasing in numbers. The stem of the diseases and accidents are from a lack of attention to ergonomics in the workplace. Nowadays, practicality during applying tasks in workplace where most people work is less focused rather than on research and high technology. Despite the application of ergonomic principles have great potential in improving productivity and the condition of workplace, but it still getting less attention from respective individual in charge especially in Malaysia. To date, the application and principles still reached only a limited number of workplaces among Malaysian employers and employees. To make it worse, the negative effect of not practicing ergonomic practices are Work Related Musculoskeletal Disorders (WMSD) like carpal tunnel syndrome, repetitive stress injuries, and back pain. WMSD are the main ergonomic diseases that need a high cost to deal with and Malaysian workers also never make a report on their ergonomic problem like minor symptoms of having ergonomic diseases. Another factor of lacking on ergonomic awareness were due to most small and medium industries had low capital and low budget constraints which disable them from hiring expertise or professional ergonomist to handle and ensure ergonomic improvements in their workplace. The lack of ergonomic awareness amongst Malaysian employees and employers may bring a long term negative effect to the firm's productivity and performance. This may reduce the productivity of the country.

Hence to overcome the problem, the objectives of the project are to identify the current ergonomic practice amongst Malaysian employees and then increase their awareness on the importance of having ergonomic practice in workplace via cost-effective mobile application in avoiding WMSD. The proposed system **ErgoApps** is a mobile application which has been developed parallel with the requirement and objective of OSHA and DOSH in ensuring occupants' health and safety but at the same time able to conduct the tasks successfully. Several manuals in managing workspace devices focusing in office

and also ergonomic interventions like simple exercise after few hours of gap are presented in the system. The aim is to create positive effects without relying on costly and highly sophisticated solutions and also preventing WMSD. Realistic solutions are needed which can be applied in a flexible manner and contributes to improved working conditions and higher productivity. With that, the proposal of the project has been presented to the respective 110 respondent via pre-survey, and the final product being tested by the respective respondent via System Usability Scale with the compromising average score of 86.60% out of 100%. Since the respondents are from desk workers and staffs that highly involved with computer-related workload, they found that the application is very useful to be use daily during working time to enhance the efficiency and performance of their tasks. To add, the application also compliant with the rules embedded by DOSH, OSHA, and NIOSH in encouraging the employees to practice a safe working environment to avoid long-term negative effects in future which may involves dreadful cost in treating WMSD.

CHAPTER 1
INTRODUCTION

1.1 Background of Study

1.1.1 Background of Ergonomic

Ergonomic term is derived from *ergo* (work) and *nomos* (laws) which are taken from Greek words. It denotes the meaning of 'Science of Work'. It is a scientific discipline and application to address the interaction of humans with all aspects of their environment. According to Frank Gilbreth in the early of 1900s he said that the essence of ergonomic lies in applying scientific principles to design processes, systems, equipment, and environments to be compatible with the needs of the given population.

In relation to ergonomic, safety is one of the main elements that widely discuss especially in Health and Safety Environment (HSE). To optimize human well-being and their overall task performance, preventing injuries and fatalities is just one of the many aspects of ergonomics. Based on Dr. Pamela McCauley Bush written in her research book entitled *Ergonomics; Foundational Principles, Applications, and Technologies*, she wrote that ergonomics fits the task to the worker, not just to prevent injury but also to increase productivity. Safety is intertwined with physical ergonomics topics such as defining optimal work postures (avoiding back pain), minimizing repetitive motions (Repetitive Stress Injuries), and facilitating a practice to prevent musculoskeletal disorders for example Carpal Tunnel Syndrome.

The classification of ergonomic discipline can be branched into three domains. Federation of European Ergonomics Societies (FEES) broadly categorized the three main domains of ergonomic as physical, cognitive, and organizational ergonomics.

- 1.1.1.1 Physical Ergonomics
- 1.1.1.2 Cognitive Ergonomics
- 1.1.1.3 Organizational Ergonomics

- **1.1.1 Physical Ergonomics**

It related to human physical activities that involved human anatomy, anthropometric, and biomechanical characteristics. Part of topics included under this domain are working posture, devices handling like telephone and mouse, repetitive movement, work-related musculoskeletal disorders, workplace layout and design.

- **1.1.2 Cognitive Ergonomics**

This domain is more on relationship between humans and other elements of a system. Example of cognitive ergonomics is concerned with mental processes like perception, memory, reasoning, and motor response. Relevant topics are stress, decision making, and skilled performance.

- **1.1.3 Organizational Ergonomics**

This ergonomics domain includes the organizational structures, policies and processes for example communication between employer and employee, team and cooperative work, quality management and task design.

All these three domains play a big role in assessing the need of preventing risk factors and mitigating the impact to the potential workers in occupational environment. In addition, by mitigating the impact of ergonomic disorder, it will enhance the outcome and defining the real optimal productivity in occupational environment.

Under this research, it will focus more on the first domain of ergonomic which is **physical ergonomic** that encourage workers to practice ergonomic working environment involving correct working posture, devices handling, combined with workplace layout and design. By practicing respective assessment, severe ergonomic disorder can be minimized like avoiding back pain, minimizing repetitive motions (Repetitive Stress Injuries), and facilitating a practice to prevent musculoskeletal disorders for example Carpal Tunnel Syndrome.

1.1.2 Background of Ergonomic Awareness in Malaysia

So far, ergonomist in Malaysia identified few factors on the lack of awareness on practicing ergonomic working environment amongst Malaysian. One of the study shows that main reason why ergonomic practice give a little impact in Malaysia is due to most manager don't have knowledge on the relationship between ergonomic and employee's performance. They even don't recognize on the possible impact of ergonomic to employee's health and safety (Loo, H.S., Richardson, S,. 2012).

Figure 1 : Malaysia Flag

Ergonomic give a little impact in Malaysia due to lack in knowledge (Yeow & Sen, 2003). Besides that the discipline of ergonomics has been regarded as new for a new developed country like Malaysia compared to other industrially developing country (O'Neill, 2000). However, the use of ergonomic concepts and principles in Malaysia started around several decades ago (Sen, 1998). Since the discipline is new or maybe unknown, hence when we talk about ergonomic awareness most manufacturing and service industries may suffer.

After Malaysia being recognized as one of the new Industrial Developing Countries (IDCs) in 1970, current agricultural economic sector was shifted to manufacturing industries with the involvement of multinational companies like Sony, Siemens, Intel, Motorola, National Semiconductor, Panasonic, and Advanced Micro Devices. Hence, many agricultural workers had to readjust their physiological and psychological capabilities to suit with current industries needs and procedures that totally different from traditional agricultural-based work (Ali et al., 2001).

In fact, in the midst of 1980's most multinational companies in Malaysia had put ergonomics as low priority since the application of ergonomic knowledge was perceived as expensive and burdensome expenditure rather than a rewarding investment. Another contribution of lacking in ergonomic awareness was due to the abundance of replaceable cheap labour and low government regulation of labour health and safety issue (Yeow and Sen, 2002).

Another factor of lacking on ergonomic awareness were due to most small and medium industries had low capital and low budget constraints which disable them from hiring expertise or professional ergonomist to handle and ensure ergonomic improvements in their workplace.

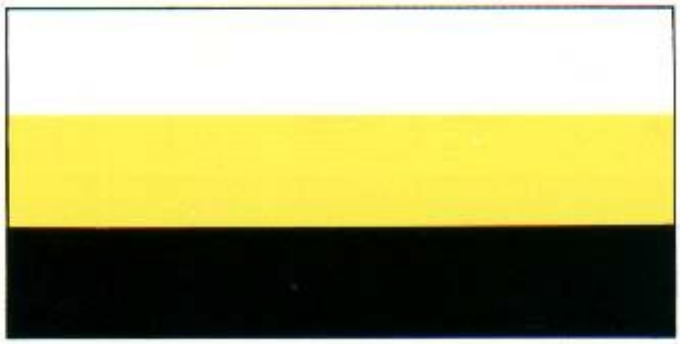


Figure 2 : Perak Flag

An industrial survey conducted on last 2001 in Kinta Valley, Perak where most of the respondents are industries engineers found out few interesting points to ponder on: (Ali et al., 2001)

→ They confuse between word "ergonomics" and "economics"

→ Most engineers considered that ergonomic only applicable to product design

→ None of the respondents had taken ergonomics or human factors engineering courses during their studies

→ They don't have knowledge on the relationship between ergonomics with industrial health and safety

In a recent study on ergonomic awareness in Malaysian manufacturing industries discovered that: (Mustafa et al., 2009)

→ Only 35.6% of Malaysian manufacturing industries have a high level of ergonomic awareness

→ 33.3% of the manufacturing industries implemented ergonomics programmes

→ Among the types of ergonomics programmes, orientation was mostly used (44.4%) and proves the most effective

→ The main factors for the lack of ergonomics awareness were the lack of information/education/training and no pressure from the top management to initiate the ergonomics programmes.

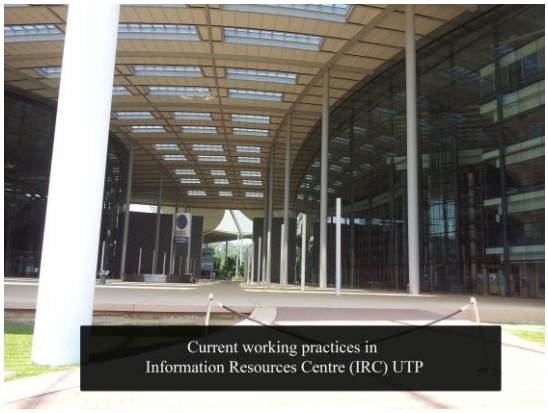
From above studies, poor local educational combine with the poor corporate education and training have contribute to the ergonomic awareness problem in Malaysia. To account for that, there are several efforts to curb these problems such as the establishment of ergonomics division in the National Institute of Occupational Safety and Health (NIOSH), the founding of the MMU Centre of Excellence for Ergonomics in 1998, and the launching of the Institute of Design and Ergonomics Application by Universiti Malaysia Sarawak in 1997. However, such efforts have hardly raised the awareness level in the corporate sectors.

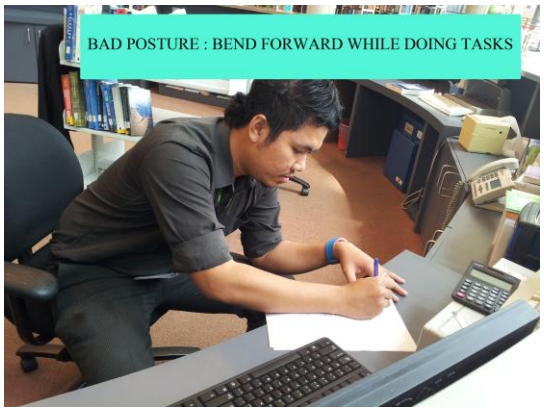
Figure 3 : NIOSH Logo

To summarize on the ergonomic awareness in Malaysia, it is a fact that ergonomic plays important role to enhance the performance and productivity of developed country together with compiling the rules and regulations from Occupational Safety and Health (OSH). However, since ergonomic development in developed country like Malaysia still in infant stage, so there are in needs of having to promote the ergonomic concepts and practice by disseminating ergonomic applications to various industries so that employers and employees become aware of design concepts and work methods that can help to improve workplace conditions and enhance workers' OSH.

1.1.3 Background of Ergonomic Practices in UTP Malaysia

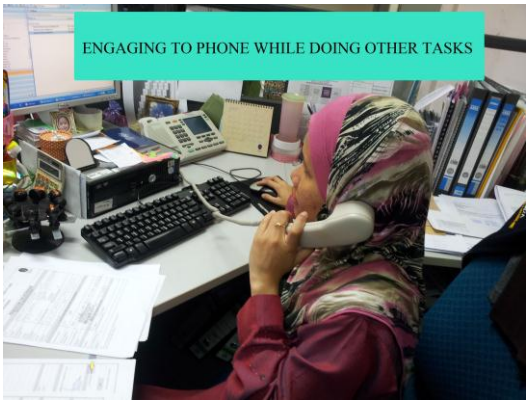
- **1.1.3.1 Ergonomic Practices in Information Resource Centre (IRC)**





- **1.1.3.1 Ergonomic Practices in Security Department Unit**

- **1.1.3.1 Ergonomic Practices in Administration Unit (Registra)**



1.1.3 Background of Android Mobile Technologies

Android is a linux-based operating system (OS) that is designed and published by Google, a search engine and internet giant. By providing an open development platform, Android offers developers the ability to build innovative applications. Developers are free to take advantage of the device hardware. Most mobile phone and smartphone manufacturers nowadays choose to develop their mobile phone to work on Android OS.

Figure 4 : Android Mascot

The main advantage of Android based mobile phone is the OS is offered in various kind of nowadays popular mobile phone brand, mainly like HTC, Motorola and Samsung.

Android was listed as the best-selling smartphone platform worldwide in Q4 2010 by Canalys with over 200 million Android devices in use by 2011. As of December 2012, there are over 100,000 Android devices activated every day.

1.2 Scope of Study

1.2.1 Target Users

This project will focus on selected targeted users which are office clerk, student, professional & non professional that involved in desk work. The need of having ergonomic practice is very high for those who directly or indirectly operate with machine like computers and other related devices.

1.2.2 Ergonomic Diseases

To study and research on the factors and risk of having Musculoskeletal Disorder resulted from desk work. Three main diseases of Musculoskeletal Disorder are Back Pain, Carpal Tunnel Syndrome, & Repetitive Strain Injuries.

1.2.3 Android Mobile Platform

To survey and study on the feasibility of developing the application as Android platform compare with other platform like iOs and BADA. A full set of questionnaires and survey have been introduced to targeted respondents and the result being studied further under Result & Discussion section.

1.3 Feasibility & Relevancy

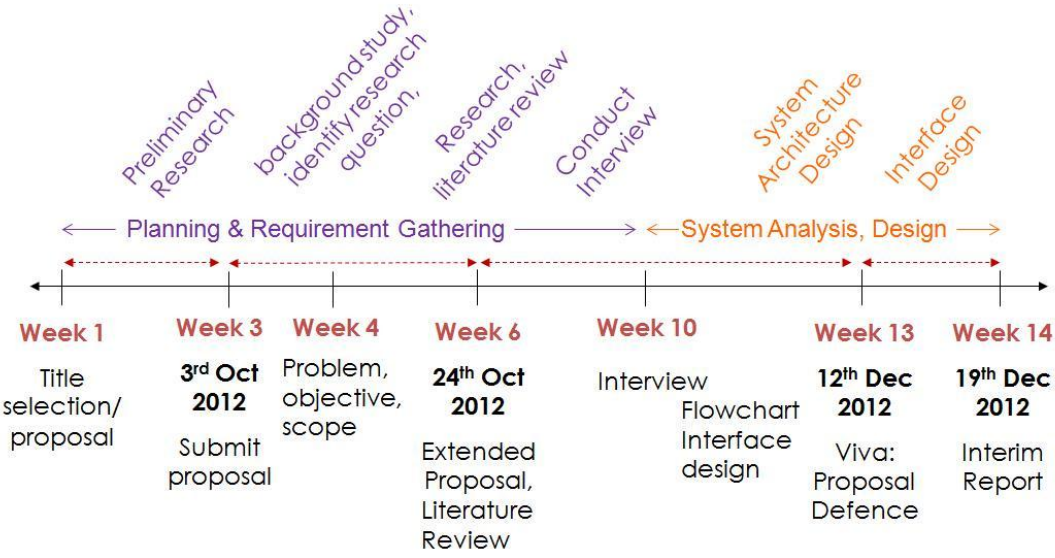


Figure 5 : Early Phase of Key Milestone

Due to time constraint and lack of resources to complete the project within time limit, author is responsible to construct own initiative to ensure the smoothness of this project. Hence, author has to separate the phase into two.

The first phase is where author able to construct on the backbone of the project which is full report and the architecture design before going further on the next phase.

The next phase is where author starts on developing the application by referring on website tutorials and attending paid Android class.

1.4 Problem Statement

Ergonomic working environment is the first step need to be concern in order to improve whole working performance. In addition, improper working environment and bad working practice may result in Musculoskeletal Disorders and other severe syndromes which are very costly to be treated. Hence, in a long run, prevention is better than cure.

Listed below are few studies related on ergonomic awareness in Malaysia and the rest of the world:

- Industrial study shows that Malaysian lack of education & knowledge on practicing ergonomic in workplace (Mustafa et.al, 2009).

- Main factor of having Musculoskeletal Disorder are due to bad working practice (bad posture, repetitive movement, forceful motion) (Kelsey et.al, 1997)

- Musculoskeletal disorders account for majority of workers compensation cost in California (Gou et.al, 2008)

Figure 6 : Ergonomic Workspace

However, technology advances especially in mobile technologies and persuasion techniques has not been fully utilize in this domain to help user practice a proper working practice. In accordance of that, there are three questions that will be raised in this project:

- How can we improve and create awareness on the state of ergonomic working environment through mobile technologies?

- How can we educate user on the prevention of Musculoskeletal Syndrome disorder through mobile technologies?

- What are the techniques suitable to persuade user and potential musculoskeletal disorder patients to have simple exercise to avoid the diseases?

1.5 Objectives of study

AIM: To explore the use of mobile technology for creating awareness on the importance of having an ergonomic working practice. The application will educate users on the correct way of handling devices and how to handle the tense after long working hour by having simple exercise.

OBJECTIVES:

1. To identify on ergonomic working practice in an identified workplace which are Information Resource Centre (IRC), security department, university registration unit, and student's hostel of Universiti Teknologi PETRONAS.

2. To survey on user's current practice in computer usage at the identified workplace for example time spent in front of monitor.

3. To survey the symptoms and factors related to musculoskeletal disorders and repetitive strain injuries among users.

4. To develop a mobile application that creates awareness on ergonomic working practice which preventing from musculoskeletal disorder, as well as an alert system to remind user to adhere to safe work practice.

5. To evaluate user perception towards the developed application.

6. To evaluate the usability of the ergonomic application to the users ranging from professional to non-professional since ergonomic working environment is vital for all fields that relate to human-machine interaction

CHAPTER 2
LITERATURE REVIEW

This chapter mainly discusses on the general idea of the project. Several keywords are discussed amongst with problems addressed in the previous chapter until the idea of the proposed solution.

2.1: Importance of Ergonomic Working Environment

Since the Industrial Revolution that based in United Kingdom and later spread to North America, and the rest of the world over 200 years ago, the work environment has changed drastically. The requirement for workers increased parallel with the need of redesigning work environment (*Pencil History, 2010*).

Figure 7 : Importance of Ergonomic

With the intent of addressing the occupational needs of human in a holistic fashion, hence the real definition of ergonomic is very broad and comprehensive. Even though there are various definition of ergonomic exist, the crucial elements lies in applying scientific principles to design processes, systems, equipment, and environments to be compatible with the needs of the given population. One of ergonomic domains that will be stressed under this project is Physical Ergonomic. It related to human physical activities that involved human anatomy, anthropometric, and biomechanical characteristics.

Part of topics included under this domain are working posture, devices handling like telephone and mouse, repetitive movement, work-related musculoskeletal disorders, workplace layout and design (*Federation of European Ergonomics Societies, FEES, 2009*).

Ergonomic workplace design and workplace layout consist of the processes, offices, factories, and equipments. All physical aspect of a task ranging from the input device, hand tools, seating, and anything the workers interacts with to complete task requirements. Nowadays many jobs require employee to be seated in front of their desktop or laptop for a long hour. However, the nature of the working space and condition of input devices may affect the health of employee and their productivity in performing tasks. Human body is a complicated system that capable in performing limited number of movements, activities, and functions. In accordance of that, human senses able to interpret external signals and allow the internal systems to respond. Hazardous conditions may be immediately sensed and to eliminate acute hazard that may degrade employee's health, workers and management must pay attention to these signals to eliminate acute hazard (*OSHA European, 2010*).

Figure 8 : Ergonomic Interior

The most effective and main priority in controlling sources of workplace stress is to recognize the workplace design and it is the main ergonomic approach. With the implementation of the ergonomic approach to work design, prevention of injury is achieved as a result of the worker experiencing improved work postures, reduced

forces, fewer repetitions, and reduction in overall exposure to risk factors (*OSHA, 1987*).

Hence, it is crucial to identify workplace factors that may contribute to ergonomic problems such as injuries, illnesses, operation discomfort, and reduced productivity. To increase the awareness of employee and management on the importance of good and conducive working environment, steps taken and principles introduced by National Institute of Occupational Safety and Health will be discussed later on under assessment and prevention of Ergonomic diseases.

2.2: Ergonomic Diseases and Drawbacks

Rapid changing in office work parallel with the new developments in computer technology will ease our task but at the same time present new problems for both management and employees. In recent years, computer work is the main focus in office ergonomic due to rapid increase in computer usage in modern office which unfortunately associated to increase of injuries and ergonomic diseases. Workers that required to a job that exert themselves over physical limitations are potential for injuries. Work-related Musculoskeletal Disorders (WMSD's) is claimed to be a single largest class of injury that account for 40% of all Washington State Fund workers' compensation claims amongst office workers. Medical and time loss cost over $12 million per year to State Fund employer due to these injuries and accounts for 70,000 loss work days per year. If compare to other injuries that due to sudden event like slip and fall, WMSD may worsen and more costly since it takes long time for employee back to work, resulting in higher medical and time loss payment (wages). In extra, hidden cost may exist when workers keep absent and slower in their work paces before they realized on WMSD's symptoms (*Washington State Department of Labour and Industries, 2002*).

Other terms for WMSD's are:

- Repetitive strain injuries (RSI)
- Musculoskeletal Disorders
- Cumulative trauma disorders (CTD)
- Repetitive trauma disorders
- Repeated motion disorders
- Overuse syndromes

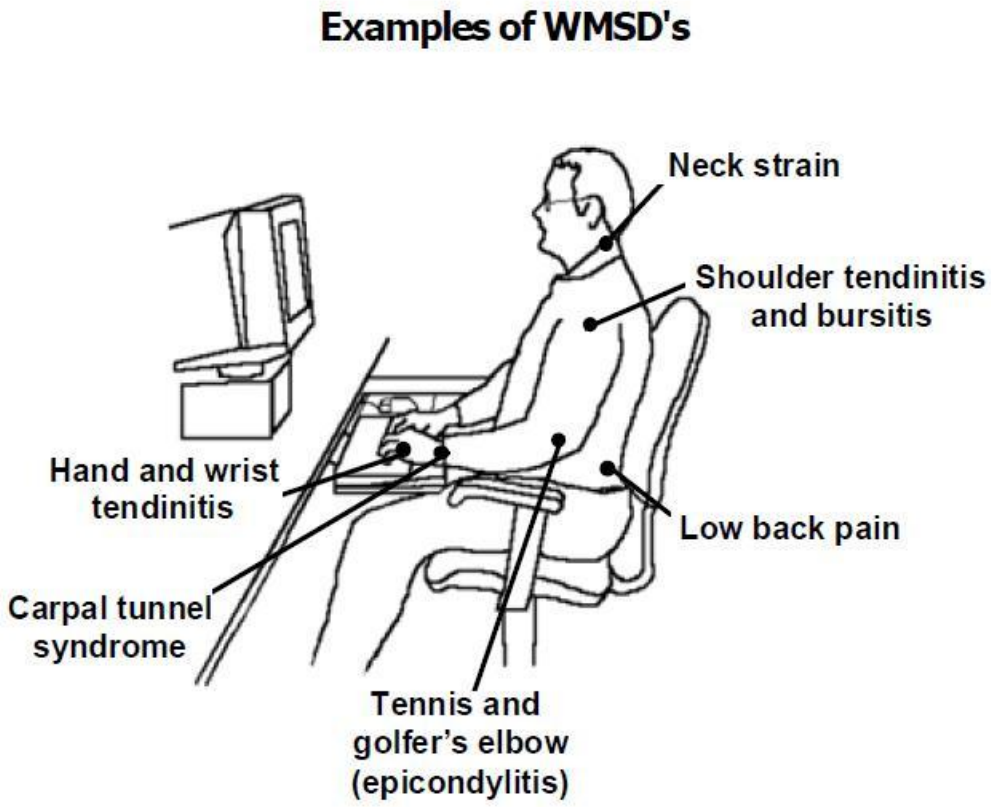


Figure 9 : Example of WMSD's

In accordance of that, it is essentially costly to deal with all those kind of injuries and diseases. Besides, both direct cost and the loss of valuable service provided by the individual indirectly burden the management and employees themselves. Human workforces are an essential part of every business process and critical in delivering quality product and services. Therefore, ergonomic disease prevention must be taken seriously by applying ergonomics to office work that helps people work more effectively, efficiently, and productively at their jobs.

2.2.1: Musculoskeletal Disorders & Repetitive Stress Injuries (RSI)

For many years, medical fields have diagnosed musculoskeletal disorders and other ergonomic diseases that resulted from working space. In the nineteenth century, Raynauld's phenomenon called as dead finger or jackhammer disease was found. The main cause of the phenomenon is due to lack of blood supply and also repetitive motion that direct to Repetitive Stress Injuries (RSI). In 1934, Hammer confirmed that tendons could not resist more than 1500-2000 exertions per hour (*Armstrong, 2002*). Record and report from 1930 all the way to 1950 showed that inflammation of tendons and tendon sheath amongst typist keep growing and common. To cater the issues, in 1940's both physicians and engineers were knowledgeable on the impact of design and operation of work space on musculoskeletal disorders. There are several types of work-related musculoskeletal disorders such as back injuries, carpal tunnel syndrome, tendonitis, and trigger finger (*Armstrong, 2002*).

2.2.1.1: Back Injuries

Back pain (also known as dorsalgia) is pain felt in the back that usually originates from the muscles, nerves, bones, joints or other structures in the spine. (*Wikipedia - Back Pain, n.d.*). Overexertion is the main cause of back pain injuries and the back is the most frequently injured part of the body which is 22% of 1.7 million injuries (*NSC, Accident Facts, 1990*). Main reason of back pain is due to general repetitive and result after months or years of task performance. Acute injury actually is the result of long-term impact. One potential source of back pain is skeletal muscle of the back. Potential causes of pain in muscle tissues include muscle strains (pulled muscles, muscle spasms, and muscle imbalances (*NSC, Accident Facts, 1990*).

Figure 10 : Causes of Back Pain

Few factors that related to back pain injuries are listed below (*Mayoclinic, 2010*).

i. **Force** – Too much force exertion on your back by lifting/moving heavy object.

ii. **Repetition –** Muscle fatigue and injury due to repeating same movement for a long period. Using awkward body positioning while stretching to the limit of your range of motion also can bring back pain injury.

iii. **Posture –** Muscle fatigue and injury cause by slouching. Slouching exaggerates back's natural curves.

iv. **Stress –** Stress and pressure at work encourage the tightness and muscle tension that lead to worsen back pain.

2.2.1.2: Carpal Tunnel Syndrome

Carpal tunnel syndrome (CTS) is one of the Upper Limb Disease (ULD). The main cause of CTS is the compression of the median nerve as it passes through the carpal tunnel at the front of the wrist. It is one of the most widely recognized under Work-related Musculoskeletal Disorders (WMSD's). The carpal tunnel is comprised of eight carpal bones at the wrist, arranged in two transverse rows of four bones each. Few symptoms of CTS are numbness, tingling, and burning sensations in the fingers.

Severe symptoms of Carpal Tunnel Syndrome include pain, wasting of the muscles at the base of the thumb, dry or shiny palms, and clumsiness. Usually the symptoms exist at night and if left untreated the pain may radiate to shoulder and elbow. (*Patient UK, 2008*)

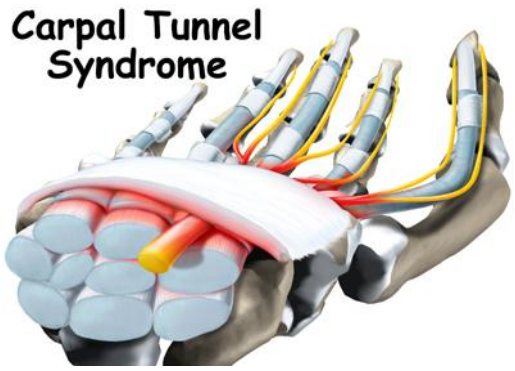


Figure 11 : Carpal Tunnel Syndrome

Other possible symptoms of CTS include (*NHS Choice, 2010*):

- A dull ache and discomfort in the hand, forearm or upper arm
- A burning, prickling sensation (paraesthesia) in the hand that is similar to pins and needles
- Dry skin, swelling or changes in the skin colour of the hand
- Becoming much less sensitive to touch (hypoaesthesia)
- Weakness in the thumb when trying to bend it at a right angle, away from the palm (abduction)
- Weakness and wasting away (atrophy) of the muscles in the thumb

Carpal Tunnel Syndrome can be caused by (*Irwin Mitchell LLP, 2012*):

i. Repeated direct pressure on the base of the palm over the carpal tunnel
ii. Repeated forceful bending of the wrist
iii. Repeated forceful pinch grips
iv. Regular heavy lifting

2.2.1.3: Tendonitis

Numerous bundles of fibers that attached muscle to bones are what we called as tendons. Repetitive motions and awkward postures resulted in tendon disorders. Two main types of tendon disorders are tendon with sheaths exist in hand and wrist, and tendons without sheaths that can be found around the shoulder, elbow, and forearm. Inner wall of sheaths consist cells that secrete slippery fluid to lubricate the tendon. The lubrication system may malfunction due to repetitive or excessive movement of the hand. Failure of the lubricating system creates friction between the tendon and its sheath, causing inflammation and swelling of the tendon area. With that, Tendonitis is the general term indicating inflammation of the tendon. (*CCOHS, 2005*)

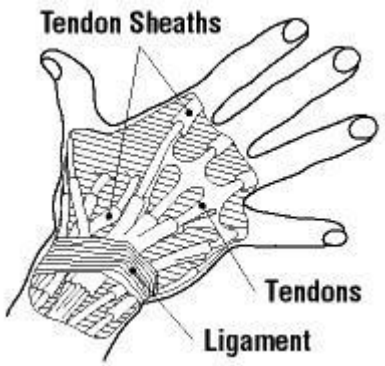


Figure 12 : Tendonitis

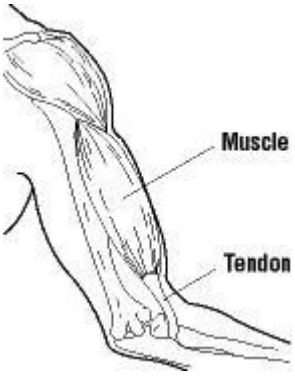


Figure 13 : Muscle & Tendon

2.2.1.4: Eye Strain

The medical term for eye strain is *asthenopia.* Eye strain occurs when eyes get tired from intense use for extended periods especially when dealing with computer tasks. Actually eye strain is not a disease but just a symptom. Eye strain is detected when the eye feel discomfort caused by looking at something for a long time. Even though eye strain is not serious since it will relieve once we rest our eyes, but it can be a sign of an underlying eye condition that need treatment (Andrew A., 2011).

Nowadays most of employee involved with computer-related job, hence computer eye strain has become a major job-related complaint. Studies show that eye strain and other bothersome visual symptoms occur in 50 to 90 percent of computer workers. These problems can range from physical fatigue, decreased productivity and increased numbers of work errors, to minor annoyances like eye twitching (Gary H., 2008).

Concentrating on visually intense task such as reading fine print, using the computer for hours at a time, or trying to see in the dark, unconsciously clench the muscles of the eyelids, face and jaws and develop discomfort or pain from use of those muscles. This may lead to a vicious cycle of tensing those muscles further and causing more distress (MedicineNet.com, 2010).

Figure 14 : Cause of eye strain

The symptoms of eye strain are listed below (Andrew A., 2011):

i. Fatigue tired eyes
ii. Blurring
iii. Headaches
iv. Doubling of vision

Few factors that contribute to eye strain are listed below (Gary H., 2008):

i. Brightness of the display and computer monitor
ii. Text size and contrast from background
iii. Colour temperature emitted from monitor display
iv. Monitor is not higher than the level of the eye

Steps taken to minimize eye strain (Gary H., 2008):

i. Exercise your eyes
ii. Take frequent breaks at least 5 minutes break every hour
iii. Modify your workstation
iv. Consider computer eyewear / eyeglass for computer task.

2.3: Risk factors in office that contribute to Ergonomic Diseases

Ergonomists have examined few jobs that create high possibilities of musculoskeletal diseases and found some common elements which associated to the injuries. These elements also known as *risk factors* since workers have a bigger chance to face ergonomic injuries if the risk factors are exposed too much. Below are the examples of risk factor to ergonomic injuries that may exist in office work: (*Pascarelli, E., and Quilter, D., 1994*)

- Repetition
- Static loading or sustained exertions
- Awkward posture
- Mechanical contact stress
- Force

2.3.1: Repetition

Doing same motion repeatedly can lead to injury. Performing similar tasks in a long period can result in trauma to the joints and surrounding tissues.

Repetition factors in computer work:

- Typing at the keyboard
- Moving and clicking the mouse
- Looking back and forth between the monitor and source document

Figure 15 : Repetitive movement

Repetition factors in office work:

- Flipping through files and paperwork
- Using a calculator
- Writing by hand
- Stapling and three hole punching by hand

2.3.2: Static loading or sustained exertions

Static loading means that in a long period of time, muscles need to hold the body in a single position. Blood circulation is hindered which causes muscle tension due to lack of movement. Besides, it can contribute to aggravate an injury. A term sustained exertions are a type of static loading where force is applied continuously for long periods of time.

Static loading in computer work:

- Holding the hands in place above the keyboard or mouse
- Holding down the Shift key
- Keeping the head still while reading from the monitor
- Sitting still for long periods of time

Static loading in office work:

- Looking down at documents laying flat on the desk
- Sitting upright without back support
- Holding handset while talking on the telephone
- Holding boxes in the hands while carrying them long distances

2.3.3: Awkward postures

Awkward postures are more likely where the joints are bends into positions that encourage injury.

Awkward posture in computer work:

- Typing with bent wrists
- Turning the head to the side to view the monitor
- Reaching up and over the keyboard to use the mouse
- Leaning over to type in data from papers laying flat on the desktop

Figure 16 : Awkward Posture

Awkward posture in office work:

- Slouching or leaning forward in the chair
- Cradling the phone between the ear and the shoulder
- Elevating the arms when writing on a work surface that is too high
- Bending at the waist to load copy machine

2.3.4: Mechanical Contact Stress

Serious injury may result if a hard or sharp surface or object pressing into the soft tissues like tendons, nerves and blood vessels.

Mechanical contact stress in computer work:

- Resting wrists on the desk edge while typing or using the mouse
- Leaning the elbow on hard chair armrests or work surfaces
- Typing with palms resting on the hard lip of a keyboard tray

Mechanical contact stress in office work:

- Using rubber stamps with handles that press into the palm of the hand
- Using scissors with hard, metal handles
- Sitting in a chair that places pressure on the backs of the thighs

2.3.4: Force

Fatigue, swelling, muscle strains and ligament strains are caused by office tasks that required moderate amount of force to be applied by very small muscles.

Mechanical contact stress in computer work:

- Dragging and dropping with the mouse
- Gripping the side of the mouse tightly
- Pounding on the keyboard

Figure 17 : Force & Pressure in workplace

Mechanical contact stress in office work:

- Grasping thick file folders or manuals
- Stapling or stamping by hand
- Opening 3-ring binders
- Lifting heavy manuals with one hand

2.4: Assessment and prevention (Steps & Alert, Toward Awareness)

The aim of ergonomics is to fit the job to the person, rather than forcing the person to fit the job. The preferred method for accomplishing this goal is to use engineering controls, which result in changes to the job or workstation and a reduction or elimination of the risk factors.

There have not been any previous ergonomic evaluations of the work environment, furniture, or related risk factors at this office. Recent changes at this company and consideration of the current condition and potential ergonomic risks presented by the current work environment prompted this evaluation and report.

In general, the following should be considered when fitting the workstation to an employee: (*Jingst, A., 2010*)

a) Is Your Chair Height Right?

To begin, adjust your chair so that your feet are on the floor and your knees are at or slightly below your hip joint level. Now, double-check this chair height with the other portions of your desk to make sure you are not too low to work at them. If this chair height is OK, move to step 2.

If the chair height is not OK, raise your chair so you can work at the set height of your desk. However, you'll need some foot support, refer to Item 3 below for more help.

b) Are Your Hands at the Right Height for the Keyboard?

i. [For Workstations with a Fixed-Height Computer Keyboard]

With this type of arrangement, the computer keyboard and mouse are located on the desk surface. Begin by checking to see if your elbows (when held at the sides of your body) are at the same height as the home row of keys on the keyboard. If not, you'll need to raise or lower the chair height sot that the elbows and your hands are at about the same height. This will place your forearms at a near-horizontal level. More importantly, this helps to keep your hands and wrists in a "neutral posture."

ii. [For Workstations with an Adjustable-Height Computer Keyboard]

Workstations with pull-out or sliding keyboard trays can usually be adjusted for height. Use the tray's mechanism (knob, etc.) to loosen the tray, and then move it up or down until you can position the home keys at your elbow height (see paragraph above).

c) Are Your Feet Located / Positioned Correctly?

After you've corrected the chair height for your keyboard use, your feet should be on the floor and the knees equal to or slightly lower than your hip joint. If not, you will need to get some kind of foot support. Commercially available foot rests are height and angle-adjustable. If a foot rest isn't immediately available, use something that is the correct thickness for the amount of support that you need. However, be sure you request a foot support as soon as possible.

d) Do You Have Adequate Back Support?

Sitting is physically demanding on certain parts of the body. One of them is the back. A chair with little or poorly designed back support can make you fidgety, and add to your discomfort.

The chair has an up - down adjustment for the back (lumbar) rest. The portion of the back rest support that protrudes forward is anatomically designed to fit into the lumbar area of your lower back. This area is usually around the belt line (it's the forward - curved area of the lower back just above the tailbone area). Adjusting the height of the back rest to match your lumbar area will actually transfer some of your seated weight from your seat and upper legs to your back, making sitting more comfortable and with less fidgeting, tenderness or numbness that can occur when seated in a poorly fitted chair.

When you sit down, position yourself on the entire seat. Sit all the way back and fit into the space between the seat and the back rest so the lumbar support can support your back.

e) Should You Use a Wrist Rest?

The purpose of a wrist rest is to prevent your wrists from drooping down during keying. Some people can hold their posture without support. But if you find that you rest your hands on the front of the keyboard or on the desk surface, then you should get some sort of support.

Get a rest with some "give" to it (not hard plastic or rubber). Try separating the wrist rest from the keyboard by 1-2 inches. This allows support for your arms without concentrating pressure on your wrists.

f) Is Your Monitor Located Correctly?

Position the monitor screen so it's vertical or at a slight tilt to prevent glare and yet give you a clear view of the screen. The top of the monitor should be set at eye level or slightly lower, and should be positioned for viewing with your head comfortably erect and balanced. This eliminates stress on your neck and shoulders.

If you wear bifocal glasses, check to see if your lower bifocal correction is for monitor viewing distance. You may need to lower the monitor a little more if this is the case. Be sure to inform your eye care provider that you use computers in your job; they can adjust your prescription to meet these needs.

Often check your monitor screen for brightness and contrast. If necessary use an anti-glare filter and keep the screen surface free of dust (*Jingst, A., 2010*).

2.4.1 Guidelines & Principles by NIOSH to avoid Ergonomic Diseases

Below are a few snippets from the principles introduced by National Institute of Occupational Safety and Health. These principles should be applied by management in ensuring a contributory working environment:

1) Tray 9-A : General Workstation Design Principles

- Ensure the workstation is flexible enough and adjustable that enables both large and small persons to fit comfortably and reach materials easily.
- Working space is big enough and sufficient for the whole body to turn. Reduce twisting motions by locating materials and tools directly in front of the worker.
- Work chair must be adjustable and properly designed that fits following standard :

- Adjustable seat height
- Adjustable up and down back rest, including lower back support
- Padding that will not compress more than an inch under the weight of a seated individual
- Chair that is stable to floor at all times (five-leg base)

2) Tray 9-B : Design Principles for Repetitive Hand and Wrist Tasks

- Reduce the number of repetitions per shift. Where possible, substitute full or semi automated systems.
- Maintain neutral handshake wrist positions :
- Design jobs and select tools to reduce extreme flexion or deviation of the wrist
- Avoid inward and outward rotation of the forearm when the wrist is bent to minimize elbow disorders (ex: tennis elbow)
- Reduce the force or pressure on the wrists and hands:
- Wherever possible, reduce the weight and size of objects that must be handled repeatedly
- Avoid tools that create pressure on the base of the palm that can obstruct blood flow and nerve function
- Avoid repeated pounding with the base of the palm
- Avoid repetitive, forceful pressing with the finger tips
- Provide support devices where awkward body postures (elevated hands or elbows and extended arms) must be maintained. Use fixtures to relieve stressful hand/arm positions.

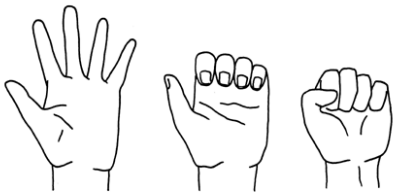
3) Tray 9-C : Hand Equipment Use and Selection Principles

- Maintain straight wrists. Avoid bending or rotating the wrists. Remember to bend the equipment or device, not the wrist.
- Avoid static muscle loading. The tools and equipment must be reduced in size and weight.
- Avoid stress on soft tissues. Stress concentrations result from poorly designed equipments that exert pressure on the palms or fingers.
- Avoid repetitive trigger-finger actions. Use equipments that can be used with all four fingers.

2.5: The importance of having simple exercise at interval hours

According to the research conducted by the American Academy of Orthopedic Surgeons recently, they found out that it is vital to have exercise at the start of work and during periodic breaks to help prevent any musculoskeletal disorders such as carpal tunnel syndrome and repetitive stress injuries (RSI). It can be more effective if the exercise can be done at the beginning of each work shift and after each break interval. The wrist and hand exercise for example able to help in decreasing median nerve pressure and the possibility of developing carpal tunnel syndrome. In the long run, daily exercise combined with job modification can help prevent carpal tunnel syndrome development. In addition, five-minute exercise and warm-up before starting work are essential for workers with hand-intensive jobs (*University of Wisconsin-La Crosse*, 2012).

Below are suggested simple exercises for targeted body parts:

Simple Exercises	Sample Figures
<u>Wrist & Hands</u> (*University of Wisconsin-La Crosse*, 2012) **a)** - Palms and fingers facing the ceiling - Separate and straighten your fingers. - Hold for 5 - 10 seconds. - Bend your fingers at the knuckles. - Hold for 5 - 10 seconds. - Make a fist. Hold for 5 - 10 seconds. - Straighten your fingers. Repeat 3 - 5 times. **b)** - Make five large circles with your thumb, in both directions. - Repeat to other thumb. **c)** - Place your palms together, so that your elbows are bent and your wrists are at right angles. - Keeping palms together push your left palm and fingers firmly against the right palm and fingers - Hold for 10-15 seconds, then release. Repeat 3 - 5 times.	 **Figure 18 : Wrist & Hand**  **Figure 19 : Thumb**  **Figure 20 : Palms Exercise**

d)

- Grasp the left hand. Keeping the left elbow straight, slowly bend the left wrist downward until you feel a stretch.

- Hold for 5 - 10 seconds. Repeat 3 - 5 times.

- Repeat with right hand.

Figure 21 : Left Hand

e)

- Grasp the left hand. Keeping the left elbow straight, slowly bend the left wrist upward until you feel a stretch.

- Hold for 5 - 10 seconds. Repeat 3 - 5 times.

- Repeat with right hand.

Figure 22 : Right Hand

f)

- Arms in the handshaking position. Slowly rotate palms down until you feel a stretch.

- Hold for 5 - 10 seconds. Repeat 3 - 5 times.

- Rotate palms up until you feel a stretch.

Figure 23 : Handshaking Arms

g)

- Slowly bend wrist from side to side as far as possible.
- Hold for 5 - 10 seconds. Repeat 3 - 5 times.

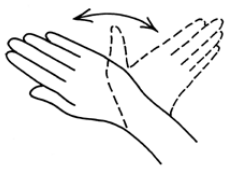


Figure 24 : Bend wrist

Shoulders & Arms

(*University of Wisconsin-La Crosse*, 2012)

a)

- Raise your shoulders towards your ears until you feel a slight tension in your neck and shoulders. Hold for 5 - 10 seconds.

- Slowly release your shoulders downward to their normal position.
- Repeat 3 - 5 times.

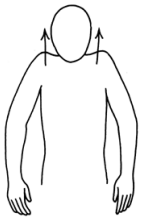


Figure 25 : Raise your shoulder

b)

- Slowly roll your shoulders backward five times in a circular motion.

- Slowly roll your shoulders forward five times in a circular motion.

Figure 26 : Roll your shoulder

c)

- Interlace fingers.
- Turn palm upwards above your head as you straighten your arms.

- Stretch and hold for 5 - 10 seconds.
- Repeat 3 - 5 times.

Figure 27 : Stretch

d)

- Fingers interlaced behind your back.
- Slowly turn your elbow outward while straightening your arms.

- Stretch and hold for 5 - 10 seconds.
- Repeat 3 - 5 times.

Figure 28 : Stretch backward

e)

- Interlace fingers.
- With palms facing out, straighten arms out to the front of you.

- Stretch and hold for 5 - 10 seconds.
- Repeat 3 - 5 times.

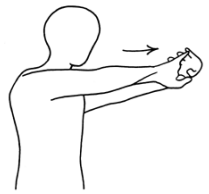


Figure 29 : Stretch Forward

f)

- Interlace fingers behind head.
- Keep elbow straight out to side. Move shoulder blades toward each other.

- Stretch and hold for 5 - 10 seconds.
- Repeat 3 - 5 times.

Figure 30 : Shoulder Blades

g)

- Hold left elbow with right hand.
- Gently pull elbow behind head until you feel a stretch.

- Stretch and hold for 5 - 10 seconds.
- Repeat 3 - 5 times.
- Repeat with other arm.

Figure 31 : Elbow stretch

h)

- Gently pull your left elbow across your chest towards your right shoulder until you feel a stretch.

- Stretch and hold for 5 - 10 seconds.
- Repeat 3 - 5 times.
- Repeat with other arm.

Figure 32 : Right shoulder stretch

i)

- Cross your arms in front.
- As you take a slow, deep breathe in, raise your hands over your head and stretch backwards.

- As you slowly breathe out, lower your arms.
- Gradually enlarge the circles, as you repeat.
- Repeat 3 - 5 times.

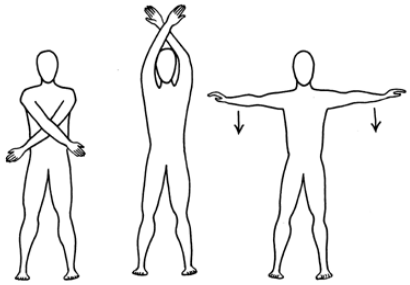


Figure 33 : Take a deep breath

<u>Back</u>

(*University of Wisconsin-La Crosse*, 2012)

a)

- Sit upright. Grasp the left knee.
- Lift left leg off the floor.
- Bend forward (curling the back), bringing the nose toward the knee.

- Repeat 3 - 5 times.
- Repeat with right leg.

Figure 34 : Knee Stretch

b)

- Stand with knees slightly bent, place palms on lower back, fingers pointing downward.
- Gently push your palms forward and bend your back backwards.

- Stretch and hold for 5 - 10 seconds.
- Repeat 3 - 5 times.

Note: Use this stretch after sitting for extended periods

Figure 35 : Long sitting stretch

c)

- Sit or stand upright
- Interlace fingers and lift arms overhead.
- Keeping the elbows straight, press arms as far back as you can.
- Slowly bend to the left side until you feel a stretch.

- Hold for 5 - 10 seconds.
- Slowly bend to the right side until you feel a stretch.
- Hold for 5 - 10 seconds.
- Repeat 3 - 5 times.

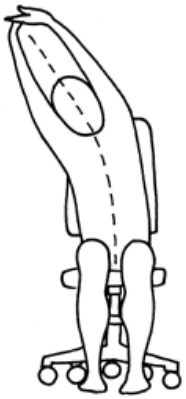


Figure 36 : Left & Right Stretch

d)

- Sit or stand upright.
- Slowly reach your arms overhead.
- Reach outward and upward until you feel a stretch.

- Stretch and hold for 5 - 10 seconds.
- Repeat 3 - 5 times.

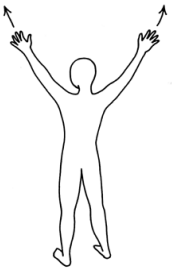


Figure 37 : Outward Stretch

e)

- Sit with left leg across right leg.
- Rest elbow or forearm of right arm on the outside of the left upper thigh.
- Gently apply pressure with right elbow or forearm towards the right.

- As you apply pressure, look over your left shoulder.
- Stretch and hold for 5 - 10 seconds.
- Repeat 3 - 5 times.
- Repeat with the other side.

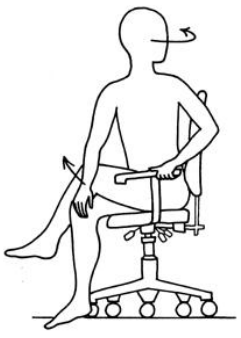


Figure 38 : Stretch while sitting

Neck

(*University of Wisconsin-La Crosse*, 2012)

a)

- Raise the eyebrows and open your eyes as wide as possible.
- At the same time, open your mouth and stick your tongue out.
- Hold for 5 - 10 seconds.
- Repeat 3 - 5 times.

Figure 39 : Eye & Tongue exercise

b)

- Sit or stand upright.
- Slide your head straight back until it feels like you have a double chin.

- Hold for 5 - 10 seconds.
- Repeat 3 - 5 times.

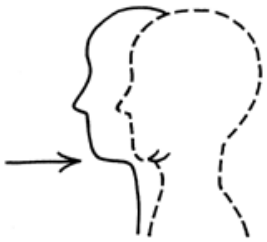


Figure 40 : Make a double chin

c)

- Sit or stand upright.
- Slowly drop your head forward, letting the weight of the head gently stretch your neck.
- Hold for 5 - 10 seconds.
- Return to neutral posture and relax.

- Slowly let your head fall backward.
- Slowly open and close your mouth.
- Hold for 5 - 10 seconds.
- Repeat 3 - 5 times.

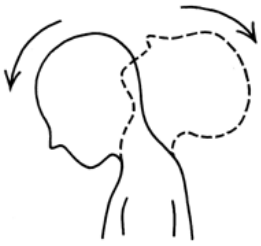


Figure 41 : Backward & Forward

d)

- Sit or stand upright.
- Slowly drop your head to the left, trying to touch your left ear to your left shoulder.
- Do not elevate your shoulder to your ear - keep your shoulder in a relaxed position.

- Hold for 5 - 10 seconds.
- Repeat 3 - 5 times.
- Repeat on the right side.

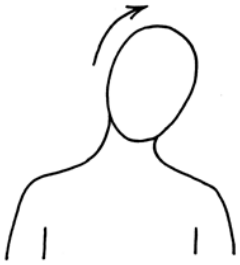


Figure 42 : Left & Right

e)

- Sit or stand upright.
- Slowly turn your head to the left until you feel a stretch.

- Hold for 5 - 10 seconds.
- Repeat 3 - 5 times.
- Repeat on the right side.

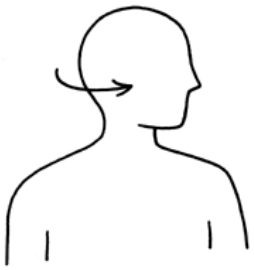


Figure 43 : Head Stretch

Eyes

(*Ramachandra. T*, 2011)

a)

- Move eyeballs from left to right and then right to left.

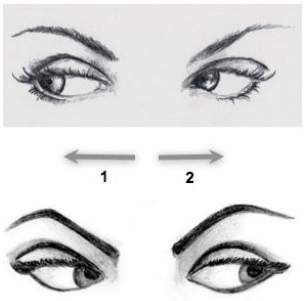


Figure 44 : Move eyeballs diagonally

- Move eyeballs diagonally by standing slightly to your right and moving the eyeballs from up to down.

- Repeat the exercise and now turning slightly to your left and moving the eyeballs from up to down.

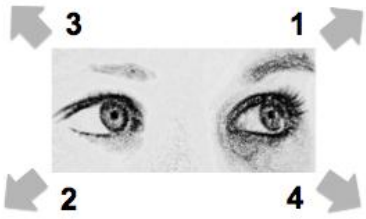


Figure 45 : Follow the direction

- Move the eyeballs straight up to straight down as shown

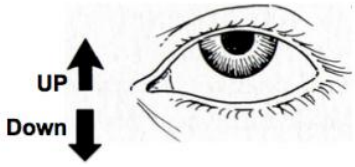


Figure 46 : Up and down movement

- Move the eyeballs to your right, then upwards and then to the left. Repeat the exercise in the other direction.

Figure 47 : Upwards, Right, and Left

- Move the eyeballs in the clockwise direction and then counter clockwise direction.

Figure 48 : Clockwise movement

Figure 49 : Anti-clockwise movement

Feet & Knees

(*University of Wisconsin-La Crosse*, 2012)

a)

- Sit upright.
- Hold left foot off the floor with left leg straight.
- Point toes up and downward.
- Repeat 3 - 5 times.
- Repeat with other side.

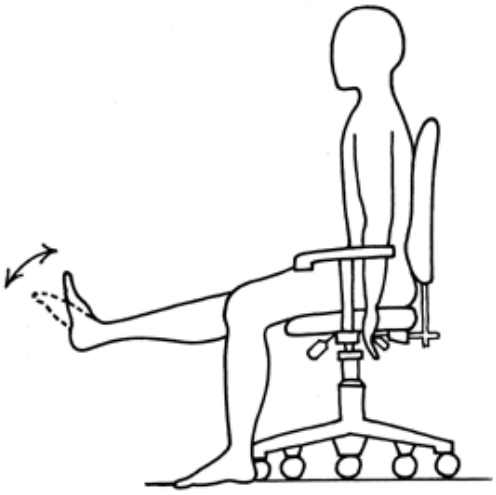


Figure 50 : Toes up and down

b)

- Sit slightly forward on the chair so your back is not touching the chair's back.
- Maintain your balance by holding onto the seat pan.
- Place feet flat on the floor.

- With leg straight, lift left foot 5 - 10 cm. off the floor.
- Hold for 5 - 10 seconds and return it to the floor.
- Repeat with other side.

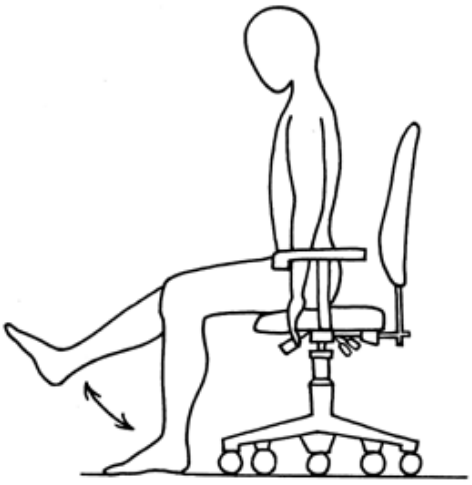


Figure 51 : 5-10 cm from floor

2.6: Existing Application/System for Ergonomic

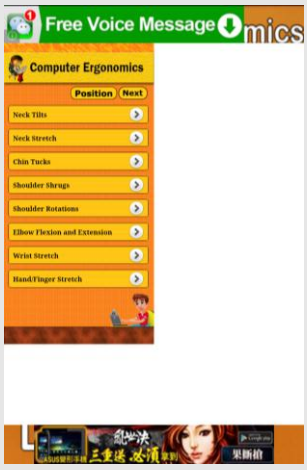
1) Name : ComputerErgo

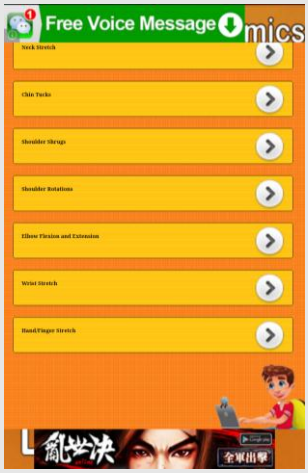
(Canny Technologies, 2012)

Description :

- Free mobile application
- Stressed on a few of suggested ergonomic exercises
- Each exercise is come up with 2D motion to enable users have a real picture on how the exercise being conducted

Screenshots & Author's Review :





- Based on author's review, this application has a bad layout orientation since it is very inconsistent with the real device's layout.

- Besides that, it is casted by a lot of external advertisements that sometimes hinder the main function of this application.

- It has ONLY two main menu : Position & Exercise.

- Type of exercise is too general for ergonomic, and not focus on certain issue such as Work Related Musculoskeletal Disorder (WMSD).

 	- Once button 'Position' is clicked, it lists down all the tips while working without displaying any image. Too simple to attract and aware user applying all the tips. - Besides that, the choosen colour is not good which is very striking and not convenient for users to read all the tips. - The back button on smartphone is not functioning for this application. Hence, it is very hard to force close this application.

2) Name : Healthy Computing

(KoolApps, 2012)

Description :

- Paid Android application
- At HOME section, this application specifies the tips on each computer devices ranging from monitors, keyboards, mouse/pointer, telephones, chairs, and more.
- The tips display encourage user to follow the correct rules in order to avoid ergonomic diseases.

Screenshots & Author's Review :

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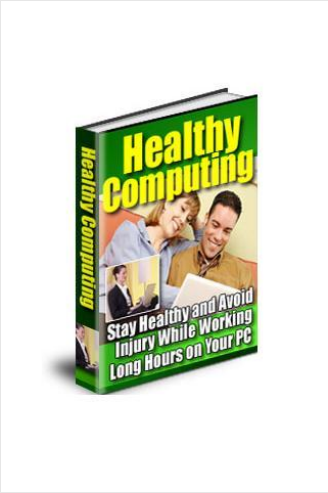

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<td>
- The splash screen of this application is the image of a book on Healthy Computing. Less interesting way to attract user using this application.

- The main menu of this application only focuses on ways of handling devices and practices while working. For example tips on handling mouse, keyboard, monitor, and chair.

- Besides that, there is no approach on urging users having exercise in preventing ergonomic diseases.
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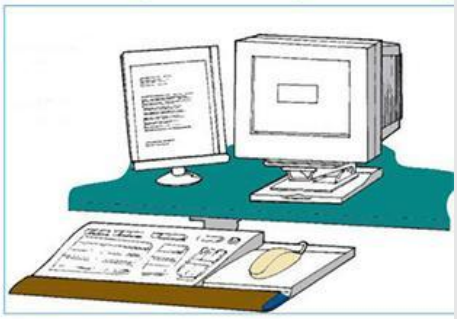
Home Settings Promo **Chapter 1: Positioning Your Body** Before discussing on how to set your computer workstation, let's have a look at the concept of neutral body positioning. This can be defined as a comfortable working posture with a natural alignment of all your joints from head to toes. This method of neutral positioning helps you reduce the stress and strain on the muscles, tendons, and skeletal system thus reducing the risks of developing a musculoskeletal	- For example, once we click on chapter 1 which is Positioning Your Body, what pop-up is the whole paragraph of the tips. There is no graphical user interface (GUI) that can interact with user.
Home Settings Promo  Fig. 3 - If your working mode necessitates looking to the document and the monitor very often, then place the document holder close to the computer as shown in the figure. **Document Holder Guidelines**	- The image use is not updated since it resembles the previous era of technologies with a bigger desktop.

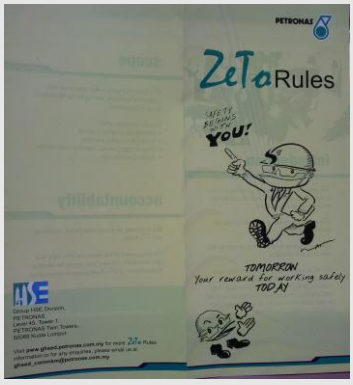
2) Name : ZeTo Rules PETRONAS

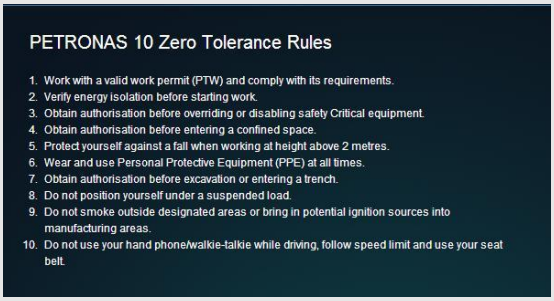
(Petronas HSE Department, 2012)

Description :

- Initiated by PETRONAS HSE Division in 2012
- ZeTo means Zero Tolerance where it is a stand-alone PC system to ensure all activities are carried out in a safe manner
-This system consists of few section where employees need to pass on before join PETRONAS
-Activities in platform and in office workspace must follow the rules stated under ZeTo rules system.

Screenshots & Author's Review :





- ZeTo rule is enclosed HSE engagement for PETRONAS employee.

- It focuses on 10 zero tolerance rules that should be followed before get involve in upstream and downstream field.

- Since it is an enclosed rules and regulations, author unable to access the system for the time being to give a few comment and reviews.

2.7: Current approach on ergonomic practice in Malaysia

Currently in Malaysia, top management usually conducts induction, training, educational and awareness program in combating ergonomics hazards. To make it more effective, wide involvement of several individuals should be included like:

- All affected employees
- Supervisors
- Medical/health care personnel
- Engineers and maintenance personnel
- Managers

These talk and seminar focus on making the job fit the worker and not to force the worker to fit the job.

Besides having similar approach, it can be followed by including the site ergonomics coordinator or consultant in the signature loop for new project or process approval (MIOSH.net, 2013).

Figure 52 : Ergonomic Seminar

Recently, Telekom Malaysia's staffs took a proactive approach by organizing a workplace ergonomics course. Assoc. Prof. Abdul Shukor was invited to conduct the course.

Figure 53 : Ergonomic Guidelines during seminar

Many took this opportunity to discuss on their current predicaments and challenges at work with respect to ergonomics. The speaker took the moment to explain on the effect of musculoskeletal disorders and bodily pains due to bad postures and uncorrected body positions.

Figure 54 : Staff from Telekom Malaysia

To emphasize, it is crucial for organizations to allow their employees to learn about ergonomics as this is regarded as proactive approaches to reduce injuries and accidents at work (Proff. Shukor, 2010).

2.8: Proposed solution and enhancement

As a whole, based on the literature reviews author need to develop an application where it is persuasive enough in order to encourage user on having ergonomic practice in workplace. Since in Malaysia, ergonomic give a little impact due to lack in knowledge, hence author need to come out with several initiatives and approaches like:

- **Ergonomic Info**

  Disseminate on all ergonomic information via the application. Ergonomic information may range from the definition, why it's very importance, requirement from organization, the drawback of not applying ergonomic practice, and how to correct current non-ergonomic working environment.

- **Ergonomic Diseases**

  User may slightly driven to have ergonomic working environment once they knew on the relationship of bad working environment to the possibilities of having ergonomic diseases. These ergonomic diseases consist of Carpal Tunnel Syndrome, Repetitive Stress Injuries, Back Pain, and Eye Strain. All of these four diseases are disseminate via this application. Besides that, the application also need to list all the factors and risks which may cause these ergonomic diseases.

- **Ergonomic Simple Exercise**

  Ensure that all the ergonomic exercises are simple enough and able to be completed by users in just few minutes. These are very crucial since most of targeted users are those involved in high tensed of desk work. So the exercises must take around 5 minutes only on each break session in order not to disturb user's current tasks.

- **Graphical User Interface designs**

  The needs of having an interesting and formal interface in order to capture non-professional & professional users. Besides that, interactive interface able to retain user's interest on this application.

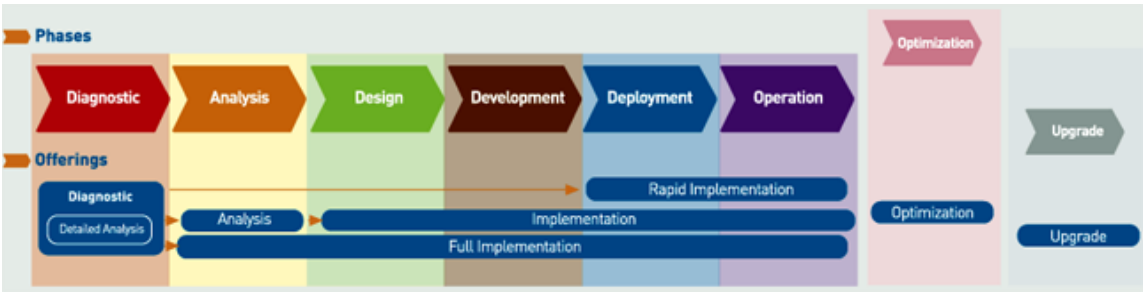
CHAPTER 3

METHODOLOGY

Before designing and implementing the software, the basic crucial thing for software development is to plan and gather the all the requirements. Few methodologies to cope with the different needs in a specific duration of time have been implemented. Under this section, those methodologies are elaborated further which consist of:

- Research Methodology
- Project Activities
- Tools Used
- Key Milestone

3.1: Research Methodology



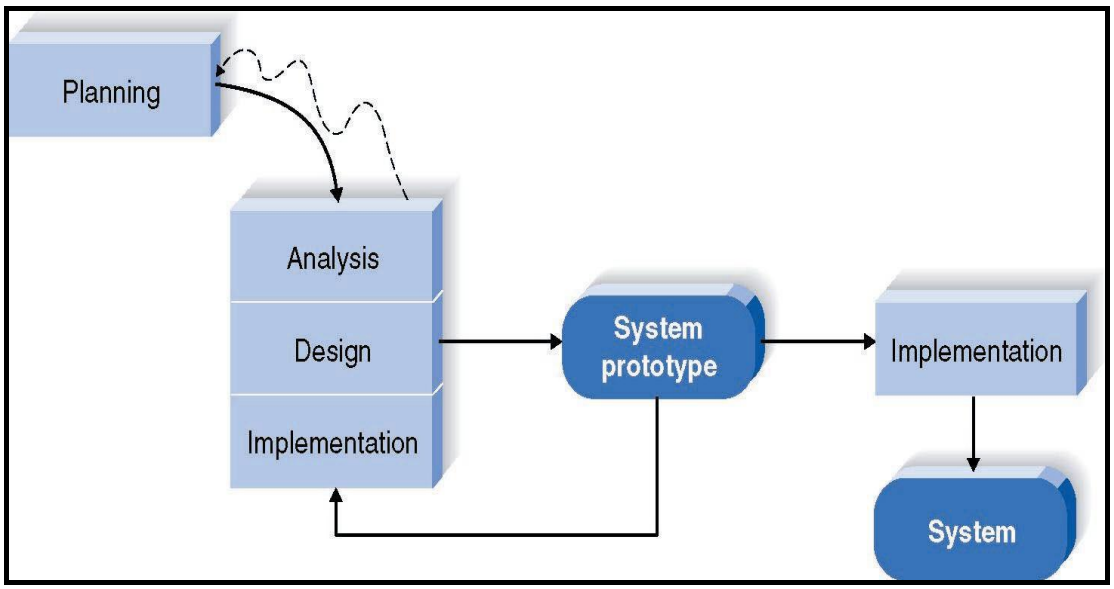


Figure 55 : The Prototyping Methodology

The research methodology for this project will focuses on reviews of books, journals, internet resources, newspaper, t-test, questionnaire and other resources that is useful in developing this project. The chosen model to be implemented is prototype model

which the analysis, design, and implementation which will be conducted concurrently until the completion.

Bowman (2009) state that, this model is useful as it lets the author to ponder a new solution to fix any problems and difficulties to make a few refinements before developing the final result. The process is involves of four stages which are planning, analysis, design and implementation.

3.1.1 Planning

For planning stage, the author is putting a few problem statements on developing this project and thinks the reasons why this project should be implemented in order to solve the problem stated. Then, data gathering process and research, to look for information in regards to the project title. The planning activities from this stage used as the baseline to monitor the project progress by stages. To ensure that tasks involves are correctly assigned, a Gantt chart is developed to make sure enough time is allocated for specific task and completed the project according to the time projected.

Planning phase is where the basic understanding about the project needs to be clarified. To dive more on the chosen topic, plan to gather all the required information from the research papers, journals, scholars, and ergonomic books specifically. Besides that, have a field visit to the respective organisation that related to occupations' health and safety like Occupational Safety and Health Administration (OSHA) and Department of Occupational Safety and Health (DOSH). Data gathering consists of the requirements that are benchmarked by those organizations, the definition of ergonomic working environment from their point of view, and how they educate employer and employee on the importance of practicing ergonomic working environment.

3.1.2 Analysis

The purpose of data analysis is to find the solution for all the problem statement of the project. Research is the most crucial in this stage in order to analyze the learning requirements for students. Journals, web-site articles, newspapers and books are widely used to find out the solution and strengthen the knowledge about the subject of research. All the related works has been gathered and reviewed in literature review part which aimed to get the importance and benefits of this project.

The information gathered during planning stage is being analyzed to cope with the problem statement and the objective of the project. During this stage, the author should identify the opportunity to reduce ergonomic pain and increase workers performance through mobile application. Example of the opportunities that should be taken seriously is the correct way workers handle the input devices, correct posture, and practicing simple exercise after specific hour. Besides that, it is important to convey the severe diseases result from bad working practice in order to create awareness to them. Hence, the respective ergonomic diseases have been analyzed under literature review section.

3.1.3 Design

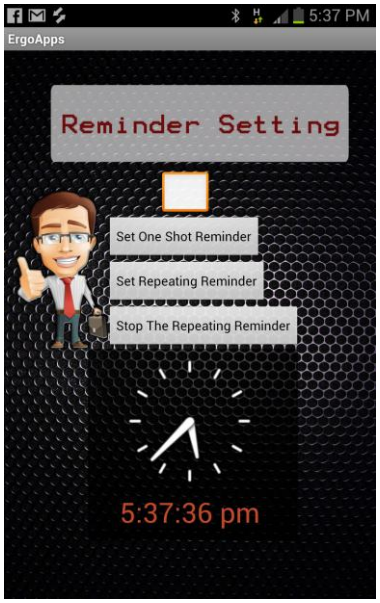
This is the stage where the real system or software will be developing. Thus, the author needs to do research on mobile apps development. Android OS smart phone will be used to test the system. The tools such as ECLIPSE Apps Inventor and Android SDK are important to write the java code to develop the project. Realizing the importance of graphical user interface, GUI towards the application, the author focuses on another interesting user interface for the application to develop. This is to capture the end user interest to use it.

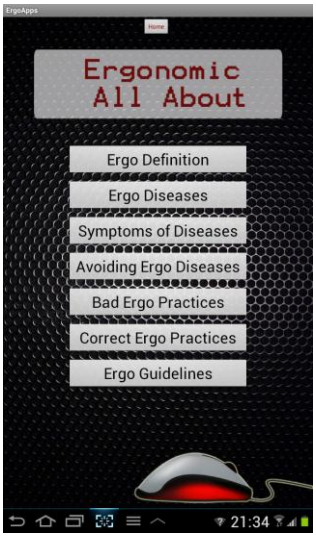
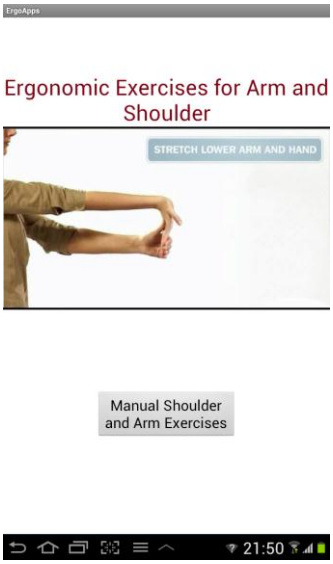
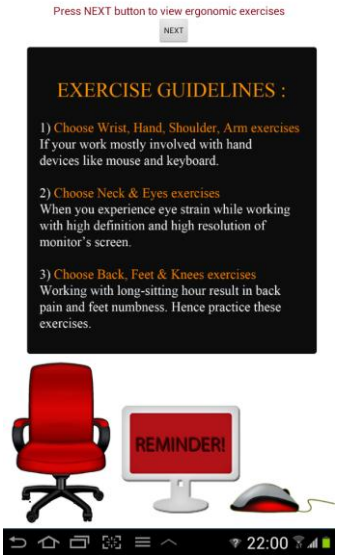
3.1.4 Implementation

This stage is important to see the results and opinions from the user to see any bugs or problems from the system. All the comments from the user will be revised to develop a better system. The system will be finalized when the user is satisfied with all their requirements and needs during User Acceptance Testing (UAT).

3.1.5 Development Phase of ErgoApps

First Phase of Development	Challenges
    	- At first phase of development, the focus is more on the information about ergonomic. Research and interviews have been done to inquire the correct information to be included inside the apps. - The information consists of all about ergonomic and correct ergonomic exercises to be practice. All of them are taken from professional guidelines. - During this phase, the reminder setting still under coding research for next phase development.

Second Phase of Development	Challenges
    	- Similar to previous phase, the information still same ranging from the ergonomic info and ergonomic exercise. - The difference part is on reminder setting where it takes me around 2 weeks to arrange the code and ensure its functionality. - As being proposed, the reminder setting has the capability to allow user include the required hours to notify them. The reminder repeat every 2 hours to remind them having ergonomic exercise. Then, user can click on stop repeating reminder to cancel the repeating notification.

Final Phase of Development	Challenges
     	- The final phase includes a lot of changes where the information has being added like the addition of live video to demonstrate the symptom of ergonomic diseases and how to avoid. - Besides that, under exercise and stretch there is a few stretch videos embedded together with manual steps on how to practice simple ergonomic exercise. - The change under reminder setting is with the addition of exercise guidelines that guide user to choose the correct exercises to be practice according to their current tasks. - Then, once user being notified with the notification page, it will redirect user to exercise and stretch page when they click on 'NEXT' button.

3.2: Project Activities

Qualitative interviews

Although interviews may be different from questionnaires in the concept of their formality they should not be considered less important. Instead, they should be used in a better state that makes the best use of their strengths. Rubin (1981) suggests that interviews are used at the beginning and end of an evaluation, initially to gather general information to form the basis for a questionnaire and afterwards to clarify its results and fill in gaps (T., 1988). Interview's result from the respective organisation that related to occupations' health and safety like Occupational Safety and Health Administration (OSHA) and Department of Occupational Safety and Health (DOSH) will be discussed further under Result and Discussion.

Questionnaires

Generally the most common way to gather data and produce a quantitative result is via questionnaires or survey. Well-designed questionnaires are able to gather information on both overall performance of the system together with the specific components of the system. Currently, author has summarized the full result of the questionnaires and survey under result and discussion section.

3.3: Key Milestone

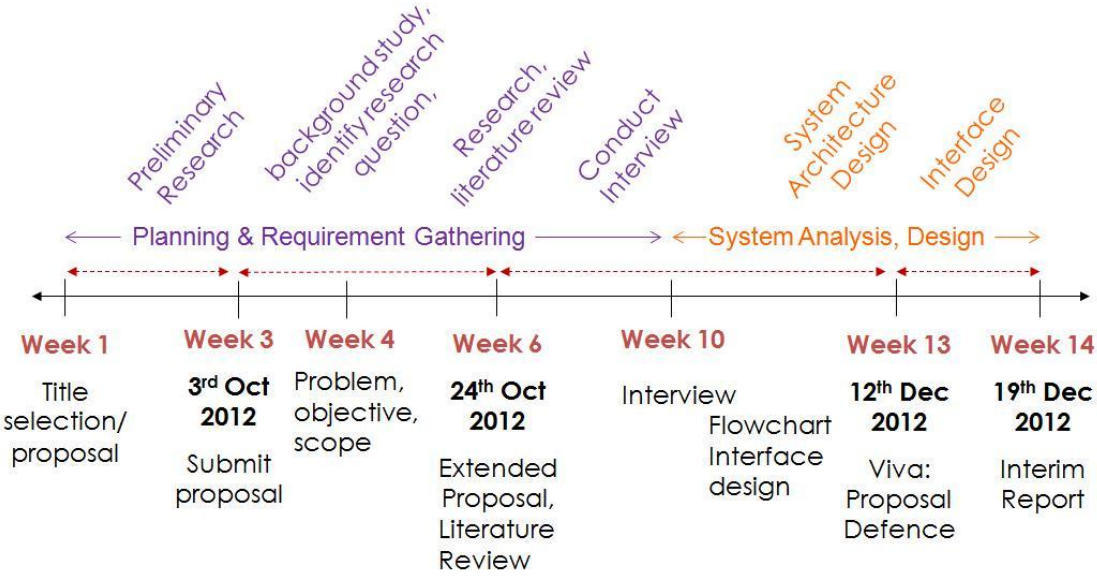


Figure 56 : Early Phase of Key Milestone

Above is the timeline of Final Year Project 1 where Planning & Requirement Gathering was conducted from Week 1 to Week 10, and continued with the System Analysis & Design from Week 10 to Week 14.

Under **Planning & Requirement Gathering**, author did preliminary research to identify on the related information of suggested topic, background study to immerse more on the topic, finding literature review to revised on previous expert researches about the topic, and continue with the qualitative and quantitative interview to gather extra data and getting respondent's feedback on suggested topic.

For **System Analysis & Design**, author started to think critically on how to develop the application beginning with the proposed flow-chart. After sketching flow-chart, Graphical User Interface (GUI) is another thing that need to be focus. By using Adobe Photoshop CS4, author sketched 6 GUI which are the splash screen, menu screen, ergonomic information, simple exercises, alarm setting, and other user options.

3.4: Gantt Chart

•Gantt Chart

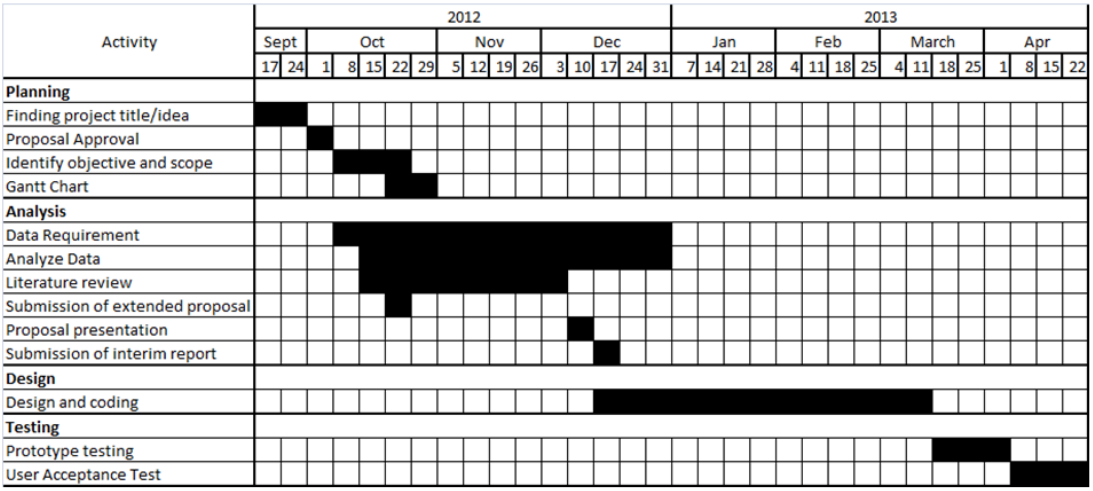


Figure 57 : Gantt Chart

Above is a full Gant-chart of Final Year Project 1 combine with Final Year Project 2 from September 2012 to April 2013. Usually planning phase is conducted at the beginning of project development life cycle. Analysis part is conducted at the middle of first month until the end of fourth month. Development and designing period will be started at the end of 4th month which is on December 2012 and finish developing the application in the middle of March or April 2013.

After completing with development phase, author needs to proceed with testing activities consist of prototype testing and user acceptance testing. Prototype testing is internal testing activity where author by herself/himself conduct testing period on the application and see whether the application is functioning as being expected or not. While for user acceptance testing or UAT, author need to gather a few of targeted respondents and get their feedback on the application whether it is usable to them or not.

3.5: Tool Used

Hardware

Debugging process during the application development requires a target machine connected to the development machine. The development machine is used to install and run Adobe Photoshop, Android SDK and **Eclipse Java** and other tools for the purpose of development only. Meanwhile, the target machine here is referring to an Android smart phone connected to the development machine using 5-pin micro-USB 2.0 cable.

Below are the specifications of the hardware used in the development of Stretch.

Development Machine Specification (CPU unit)

- Processor – Intel Pentium (2.00ghz)
- RAM – 4.00 GB of DDR2 2 GHz memory
- Platform – Microsoft Windows Vista Home Premium (32-bit)
- Browser – Google Chrome 20.0.1132.57

Target Machine Specification (Samsung Galaxy Note)

- CPU – Dual-core 1.4 GHz ARM Cortex-A9
- GPU – Mali-400MP
- RAM – 1GB
- Platform – Android v2.3.5 (Gingerbread)
- Internet – 3G, GPRS, EDGE, Wi-Fi

Figure 58 : Samsung Galaxy Note

Software

- Application/Android Development

JAVA ECLIPSE (Android Coding System)

Figure 59 : Eclipse Logo

Eclipse is a multi-language software development environment comprising workspace and an extensible plug-in system. It is written mostly in Java. It can be used to develop applications in Java and, by means of various plug-ins, other programming languages including Ada, C, C++, COBOL, Fortran, Haskell, Perl, PHP, Python, R, Ruby (including Ruby on Rails framework), Scala, Clojure, Groovy, and Scheme. (Wikipedia, 2012)

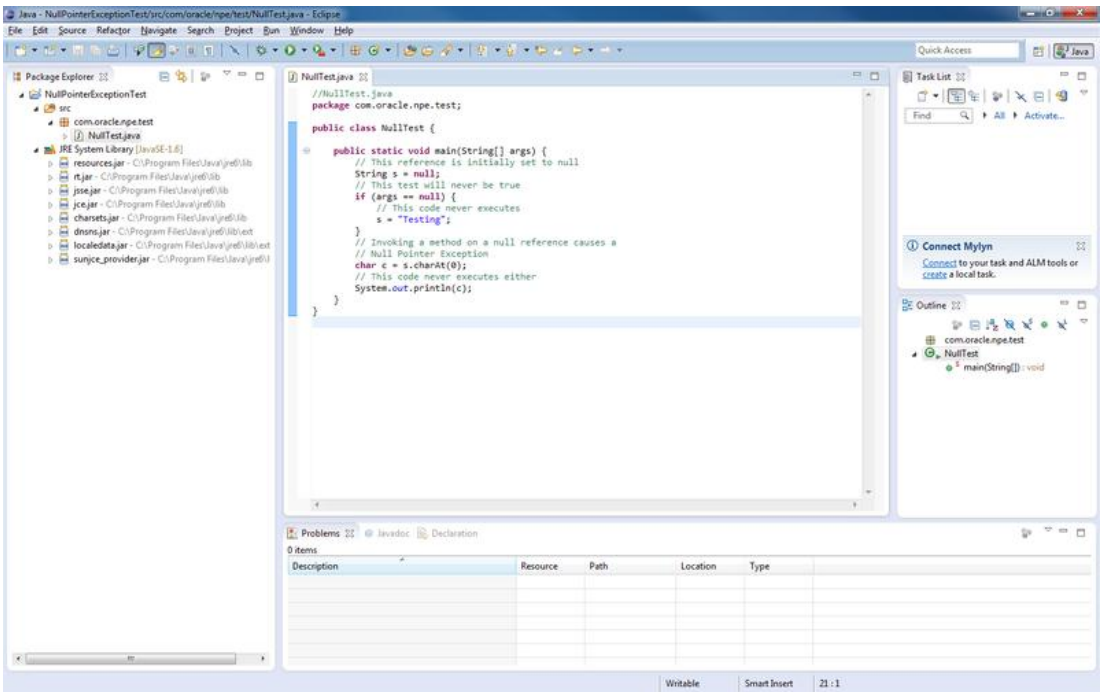


Figure 60 : Coding in Eclipse

➢ Graphic Development

Adobe Photoshop CS5

Adobe Photoshop is a popular designing application that is used to create graphic designs and photo manipulation. In this system, it was used to design the interface as well as components such as characters and buttons.

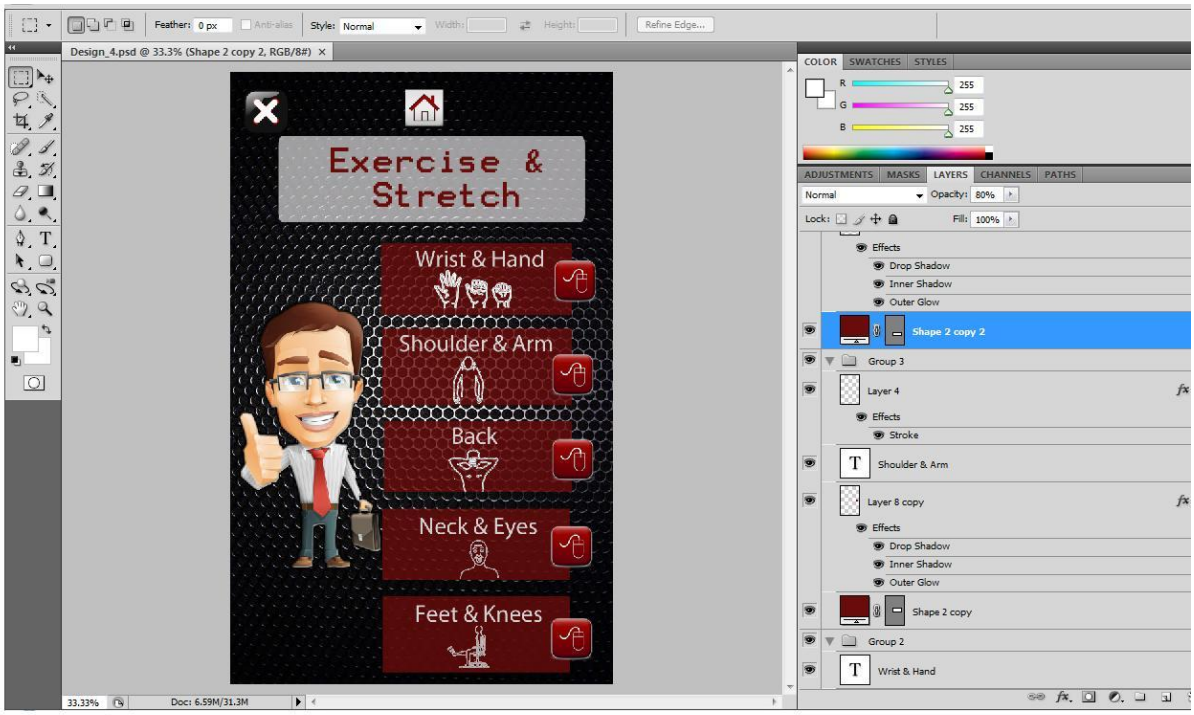


Figure 61 : Adobe Photoshop CS4

CHAPTER 4
RESULT AND DISCUSSION

This chapter discusses on all of the results collected from most of the phases in the system development process. The result helps to support the evidence towards achieving the objectives together with the discussion. This chapter will describe on several main aspects mentioned below.

4.1: Result from Qualitative Interview

It is important to gain knowledge about the issue from the expertise. Qualitative interview has been conducted successfully with Department of Occupational Safety and Health (DOSH) in Ipoh branch on last Friday, 19th October 2012. A set of interview questionnaires has been issued to the respective DOSH officer. The questionnaires aim to help developer understand more deeply on the general issue related to ergonomic practice. The interview conducted also in objective of studying factors that lead to involvements of workers in practicing ergonomic working environment in preventing musculoskeletal disorders and Repetitive Stress Injuries. The result of these studies will be analyzed and few solutions will be suggested to inhibit ergonomic severe diseases as mention before via awareness channeled using Android application which will help in producing safer working space. The questionnaires are as per attached under appendices section and the answer has been summarized on chapter 1 till chapter 3.

Figure 62 : Interview with DOSH Officer

4.2: Result from Quantitative Interview

A pilot study was done earlier before the system was implemented in order to understand more about the scenario in this problem. A set of questionnaire has been issued to 110 participants ranging from student, office clerk, and professional around Universiti Teknologi PETRONAS. Targeted department are Information & Resource Centre (IRC), Security Department, and also Registra Department. Participants were given the questionnaire through hand-out, email and social network. This question aims to help the developer understand the general perception on the issue of ergonomic working environment and how they cope with the related problem. The result of the survey are carefully study and shown below together with the chart. In addition, full version of survey and questionnaire are attached at appendices for future reference.

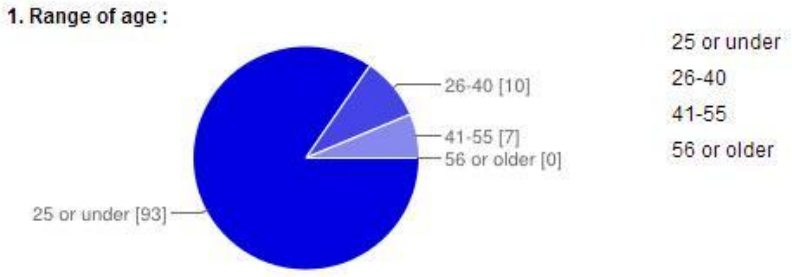
4.2.1 OBJECTIVE OF THE SURVEY:

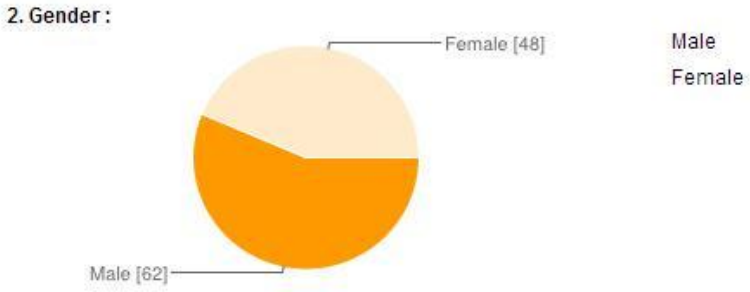
The objective of this survey is to examine factors that lead to involvements of workers in practicing ergonomic working environment in preventing musculoskeletal disorders and Repetitive Stress Injuries. The result of this survey will be used to inform the design of an awareness application deployed via mobile Android devices. Please be informed that confidentiality of the respondent is guaranteed. Information collected from this survey will be used for reporting only. Thank you for your participation.

4.2.2 FULL RESULT OF PRE-SURVEY:

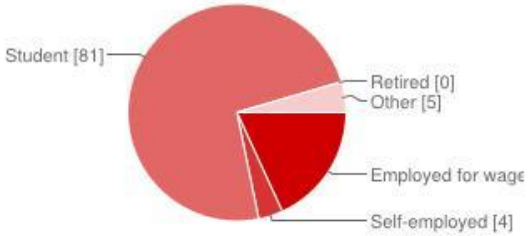
Part 1 : Demographic

Under Demographic section, data collected about the respondents are the age, gender, employment status, occupation, working experience, and time spent in front of monitor per day. All respondents mostly young executive and spending around 5-6 hours in front of computer and completing task in work space. Full result together with the percentage can be analyzed below:



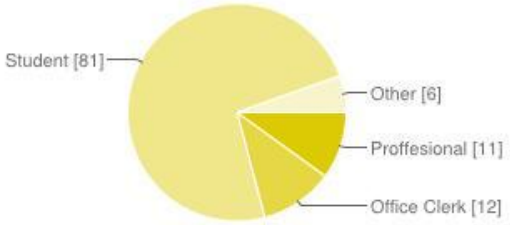


3. What is your current employment status?



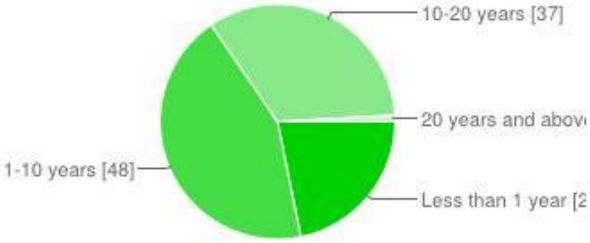
Employed for wages
Self-employed
Student
Retired
Other

4. Your occupation :



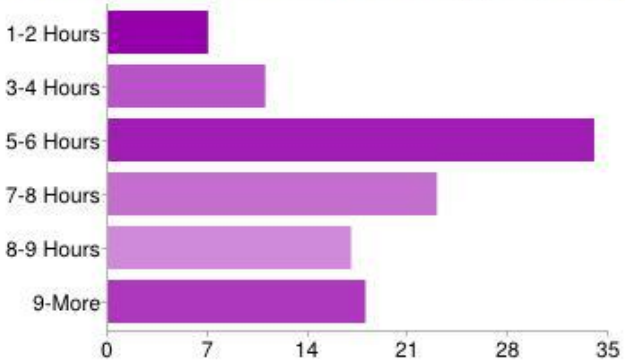
Proffesional
Office Clerk
Student
Other

5. How long have you work in this area?



Less than 1 year
1-10 years
10-20 years
20 years and above

6. Time spent in front of monitor or on working space per day?

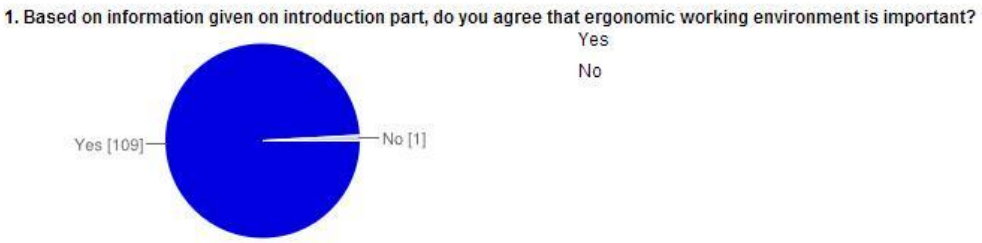


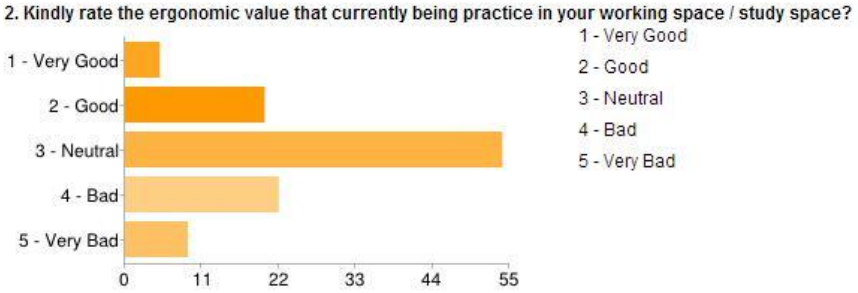
1-2 Hours
3-4 Hours
5-6 Hours
7-8 Hours
8-9 Hours
9-More

Part 2 : Awareness and General Knowledge

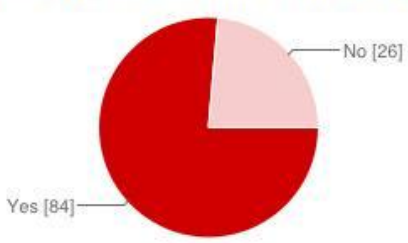
Under part 2, respondents being asked about their knowledge related to ergonomic working environment. At the beginning of the survey, author shared informative link and explanation on the basic meaning of ergonomic working environment and also severe diseases that resulted from bad working experience. In summary, most of them are aware on the importance of working environment, the severe disease resulting from bad working environment, and the worst condition of Musculoskeletal Disorders and Repetitive Stress Injuries. However, the condition of their working space mostly toward negative which is 77% of neutral, bad and very bad. To make it worse, 79% of their employer never took action of the bad working environment evolve around their employee.

The analyzed result show that three main factors which contribute to the feeling of fatigue during working hour are **repetitive task involving devices like mouse and keyboard** with 51%, **lighting from monitor and other light-beam devices** like projector and slide with 53%, and **condition of the office chair** or working chair with 59%. Hence, actions must be taken to improve these worst working environments for example by introducing a personal ergonomic application like Ergo-Apps.

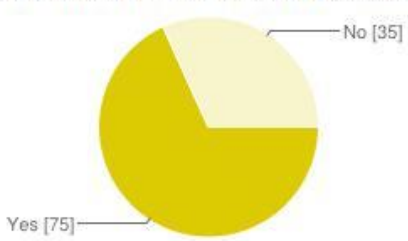




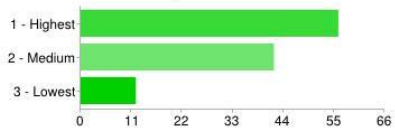
3. Are you aware of the severe diseases resulting from non ergonomic working environment?



4. Have you ever heard on Musculoskeletal Disorders and Repetitive Stress Injury?

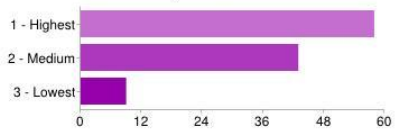


5. Please rank the following factors which contribute to the feeling of fatigue during working hour - Repetitive task involving devices like mouse and keyboard



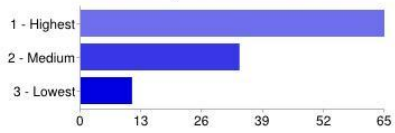
1 - Highest	56	51%
2 - Medium	42	38%
3 - Lowest	12	11%

5. Please rank the following factors which contribute to the feeling of fatigue during working hour - Lighting from monitor and other light-beam devices like projector and slide



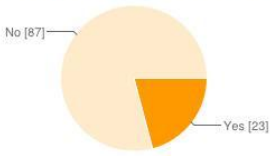
1 - Highest	58	53%
2 - Medium	43	39%
3 - Lowest	9	8%

5. Please rank the following factors which contribute to the feeling of fatigue during working hour - Conditon of your office chair / working chair



1 - Highest	65	59%
2 - Medium	34	31%
3 - Lowest	11	10%

6. Is there any solution or steps taken by office/hostel administration or Health Safety & Environment Department to inhibit this issue in your working space?



Yes	23	21%
No	87	79%

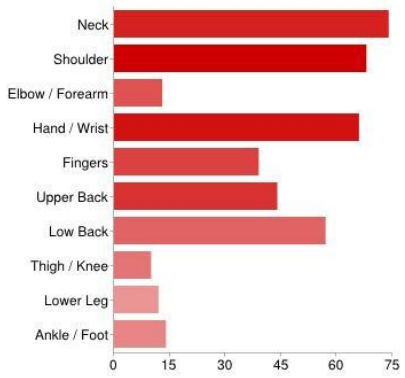
List of other factors that may contribute to the pain (Based on Section 2, Q5) :
1) The height between chairs and desk
2) Environment and temperature
3) Bad design of input device like mouse and keyboard
4) Improper placement of input device like mouse and keyboard
5) The bad posture and long working hour
6) Back-aching
7) Continuous and non-stop working without any movement

Figure 63 : Open Responses

Part 3 : Symptom Survey

This section is in objective to study factors that lead to ergonomic diseases in working space. Survey based on WISHA Services Division, Washington State Department of Labour and Industries. Based on the result, the body parts that always experience pain during working hour are 74% neck, 68% shoulder, 66% hand and wrist, and 57% are lower back. The symptoms of the pain are aching and cramp, numbness or tingling, pain, stiffness, and weakness. These are most common among desk workers whose undergo long working hour. Due to these problems they lost around 1 hour of working to cope with the pain. However, they rarely stop from doing their tasks and mostly practice simple exercise to reduce the pain. Hence 70% of the respondents are really in need of an alarm application that will alert them to take a break from long working hour and do some simple exercise to avoid pain.

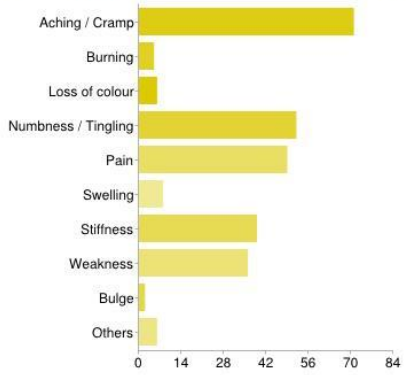
1. Usually when you are in a long working hour, which body part/parts always experience pain?



Neck	74	68%
Shoulder	68	62%
Elbow / Forearm	13	12%
Hand / Wrist	66	61%
Fingers	39	36%
Upper Back	44	40%
Low Back	57	52%
Thigh / Knee	10	9%
Lower Leg	12	11%
Ankle / Foot	14	13%

People may select more than one checkbox, so percentages may add up to more than 100%.

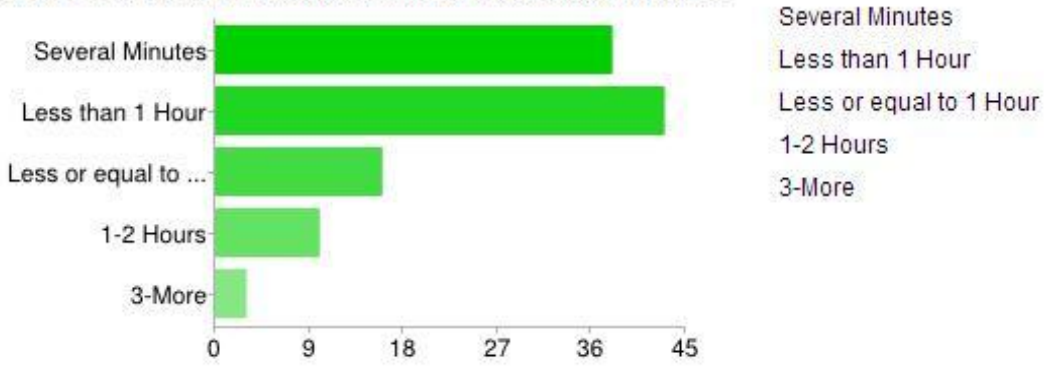
2. Based on previous question, what is the symptom of the pain?



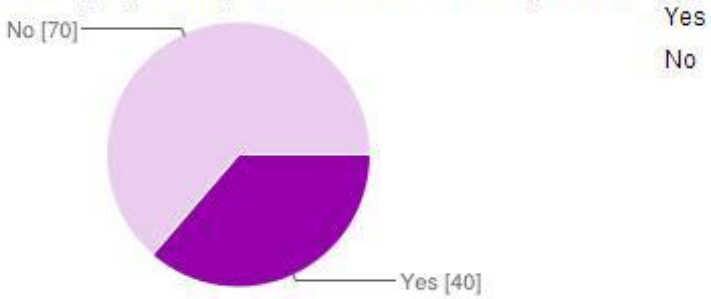
Aching / Cramp	71	65%
Burning	5	5%
Loss of colour	6	5%
Numbness / Tingling	52	47%
Pain	49	45%
Swelling	8	7%
Stiffness	39	35%
Weakness	36	33%
Bulge	2	2%
Others	6	5%

People may select more than one checkbox, so percentages may add up to more than 100%.

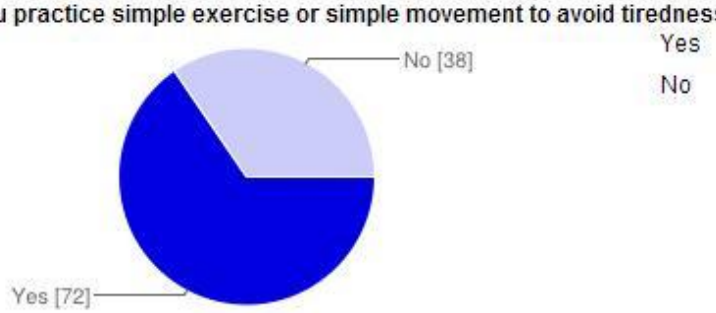
3. How much time have you lost from work due to this problem?



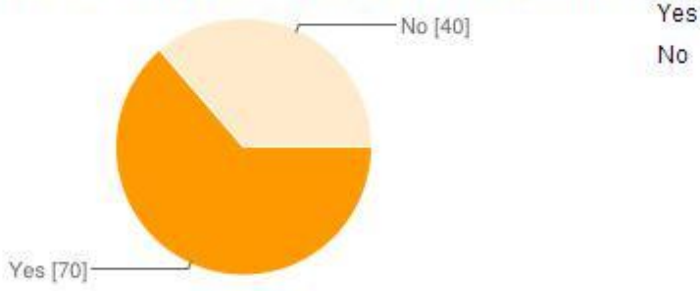
4. Have you changed jobs/ stop the task because of this problem?



5. Do you practice simple exercise or simple movement to avoid tiredness on certain body part?

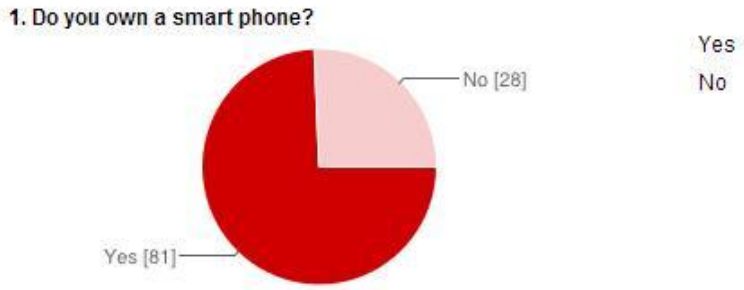


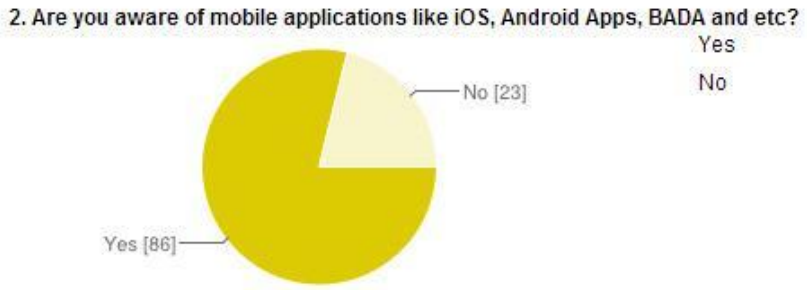
6. Do you need a reminder and alert you to take a break from long working hour?

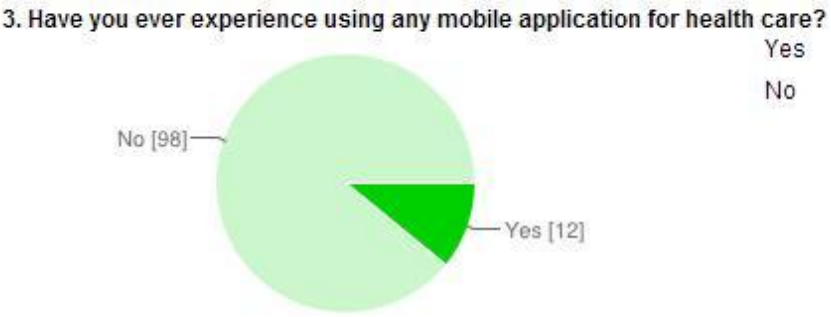


Part 4 : Health Care Mobile Application

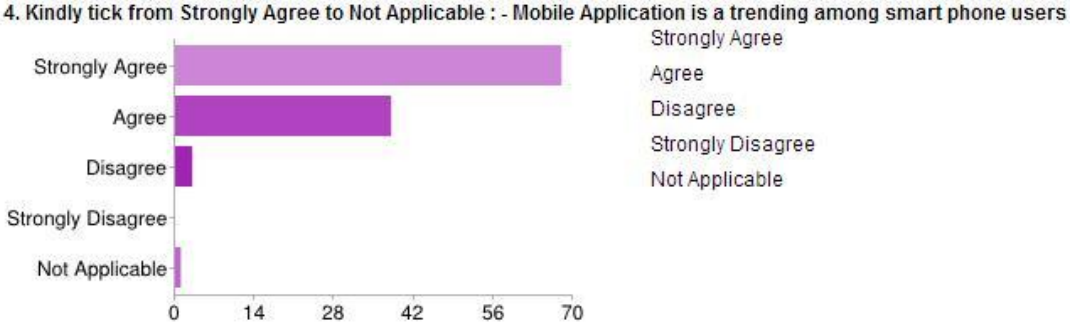
Under this section, author wants to gather the acceptance of respondent if there is an ergonomic system implemented as mobile application. Most of the respondents are smart phone user installed with Android operating system. They also agree with the implementation of Ergo-Apps as mobile application since it is currently a trend and very easy to use and install it rather than being installed in personal computer which is not portable. In overall, 95% of respondents accept the idea of implementing an ergonomic alert system as mobile application, with the combination of 37% strongly agree, 30% agree, and 28% of neutral.



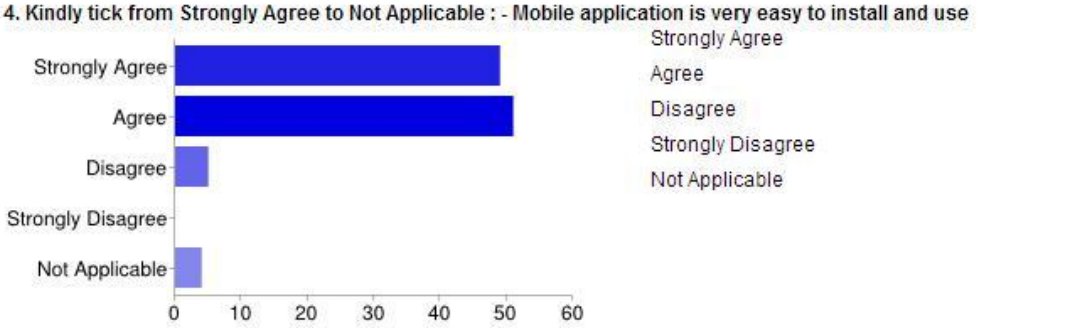




4. Kindly tick from Strongly Agree to Not Applicable : - Mobile Application is a trending among smart phone users



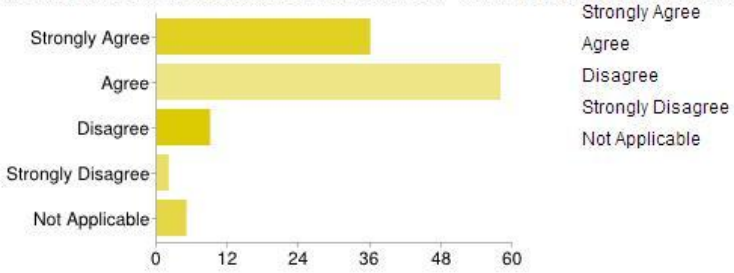
4. Kindly tick from Strongly Agree to Not Applicable : - Mobile application is very easy to install and use



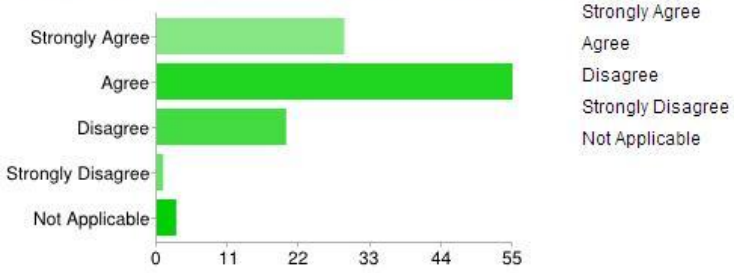
4. Kindly tick from Strongly Agree to Not Applicable : - Health care application better being implemented as mobile application rather than software in PC

4. Kindly tick from Strongly Agree to Not Applicable : - Health Mobile Application can enhance your health

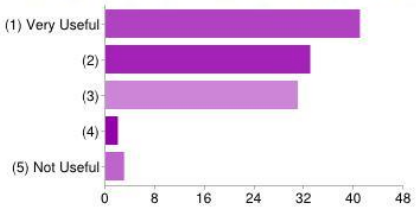
4. Kindly tick from Strongly Agree to Not Applicable : - Mobile application can invoke and create health awareness



4. Kindly tick from Strongly Agree to Not Applicable : - Mobile Application can be one way to reduce Ergonomic disease in workplace



5. Ergo-Apps – Currently I am developing an Android mobile application to raise awareness on ergonomic working environment. It gives reminder/alert users to have simple exercise/movement at interval of few hours to avoid ergonomic diseases like Musculoskeletal Carpal Syndrome and finger numbness.



(1) Very Useful	41	37%
(2)	33	30%
(3)	31	28%
(4)	2	2%
(5) Not Useful	3	3%

Comment about Ergo-Apps application:
1) I think it's a great idea like an alarm system especially for those working long hours in offices. However, it's important that you recommend exercises or movement activities that are simple and effective because if they are too complicated or require certain equipment to perform, people might just lose interest. So, maybe you could do some research on that and come up with something interesting that is user friendly
2) Make some game from the apps that need use some hand movement using accelerometer.
3) Make sure the application is free of charge so that it will be beneficial to others
4) I think you must acknowledge them first (intro about the diseases and the consequences) and, try to apprehend them to apply the guidance that you are providing for. Make it as interactive as you can yet simple.

Figure 64 : Open Responses

4.3 CONCEPT DESIGN

4.3.1 Framework & Flow-Chart

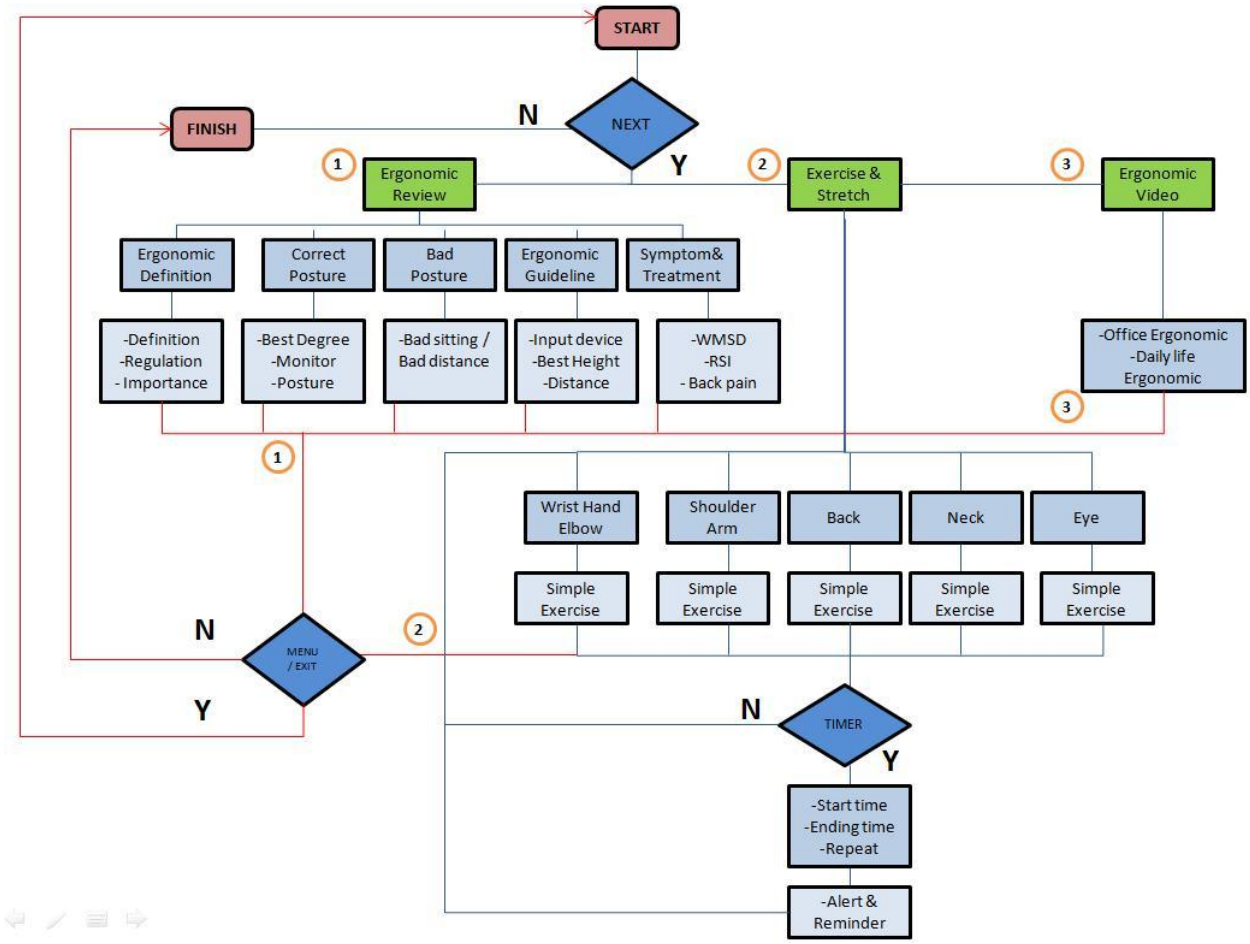


Figure 65 : Proposed Flow Chart

The figure above shows the core user interaction with the planned system. The intended user will go through these processes. The main framework of the functionality can be best explained through the figure below as being sketched using Adobe Photoshop CS5.

4.3.2 System Architectures

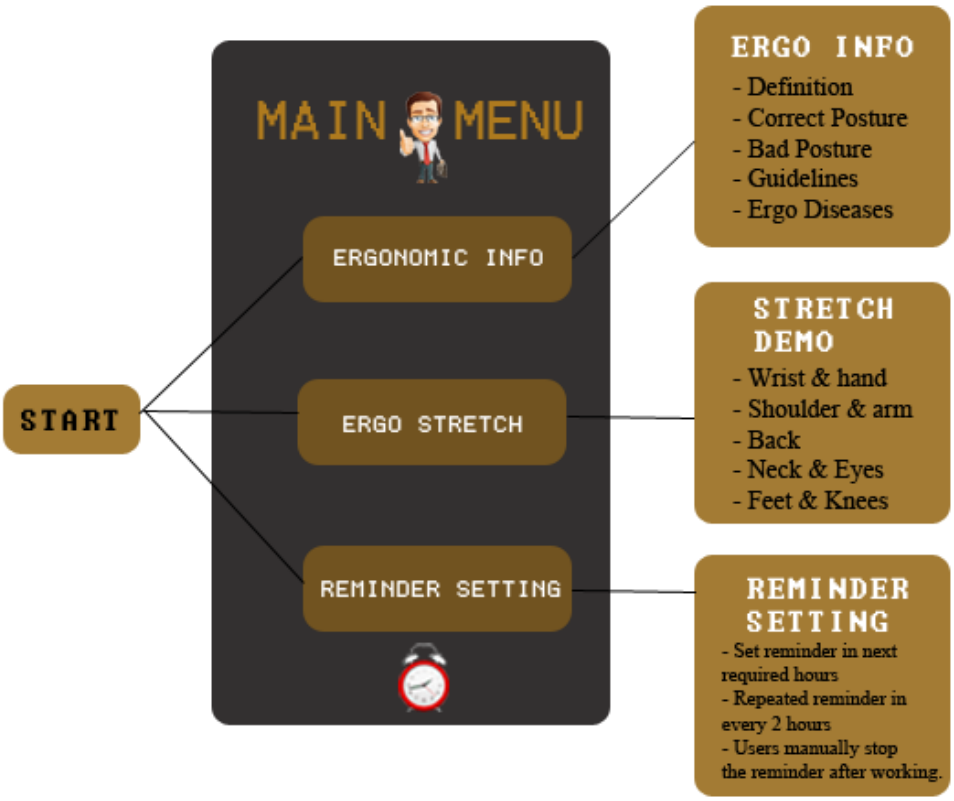


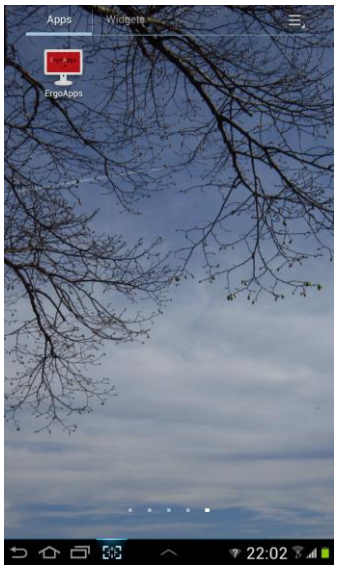
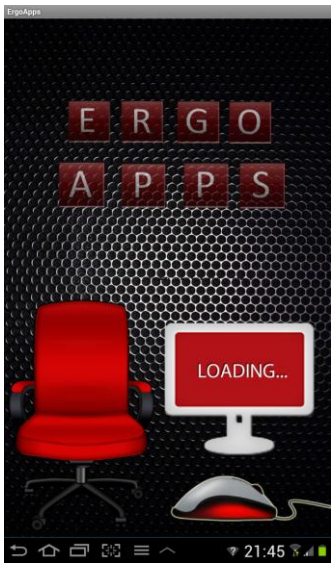
Figure 66 : ErgoApps System Architectures

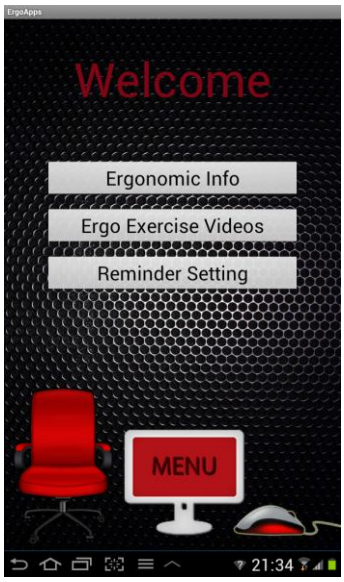
The figure above shows the core user interaction with the ErgoApps application starting from main splash screen, go to menu screen, and choose three main menu options which are Ergonomic Info, Ergo Stretch, and Reminder Setting.

If user chose **Ergonomic Info**, there are a few of ergonomic reviews in term of definition, correct posture, bad posture, guidelines and ergonomic diseases. Each part will display the right techniques of sitting, good posture and also video explaining the symptoms of ergonomic diseases and a video on how to avoid the ergonomic diseases complaints.

Whereas if user click on second button which is **Ergo Stretch**, the application will redirect users to a page that lists all ergonomic exercise videos and their manual steps. The third button is **Reminder Setting** that allows user to insert required hours to alert on having ergonomic exercises. The notification will keep notifying the users every 2 hours and will stop once user click stop repeating reminder button. Once the notification appears, it will redirect the user to the ergonomic exercises page.

4.3.3 Final Graphical User Interface (GUI)

Start	
 Figure 67 : ErgoApps Icon  Figure 68 : ErgoApps splash screen	- ErgoApps icon that already installed in Android devices. - Once user clicks on the icon, the splash screen of ErgoApps will loading for 5 seconds.

Main Menu	
 Figure 69 : ErgoApps main menu screen	- Once the splash screen finish loading, there is a main menu screen that contains three main options which are Ergonomic Info, Ergo Exercises Videos and Reminder Setting.

a) Ergonomic Info

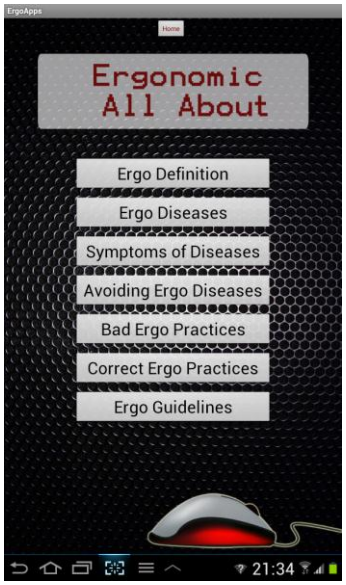


Figure 70 : Ergonomic Info screen

- Under **Ergonomic Info**, there are a few of ergonomic reviews in term of definition, correct posture, bad posture, guidelines and ergonomic diseases.

i) Ergo Definition

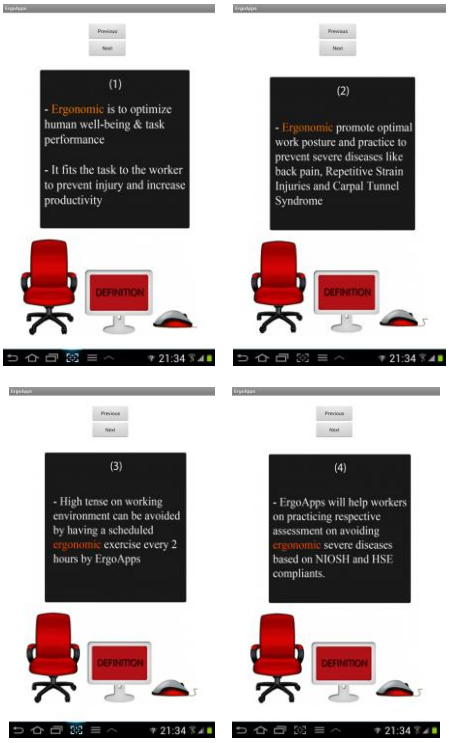
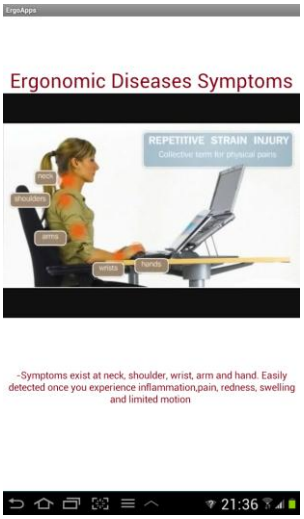
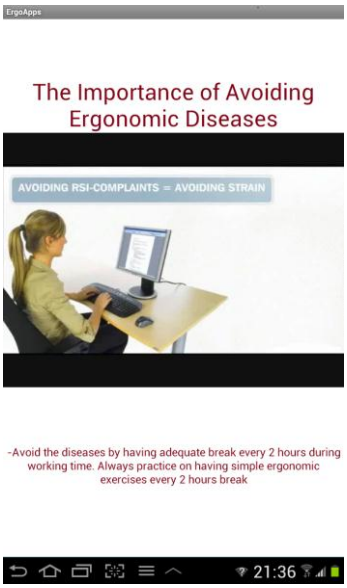
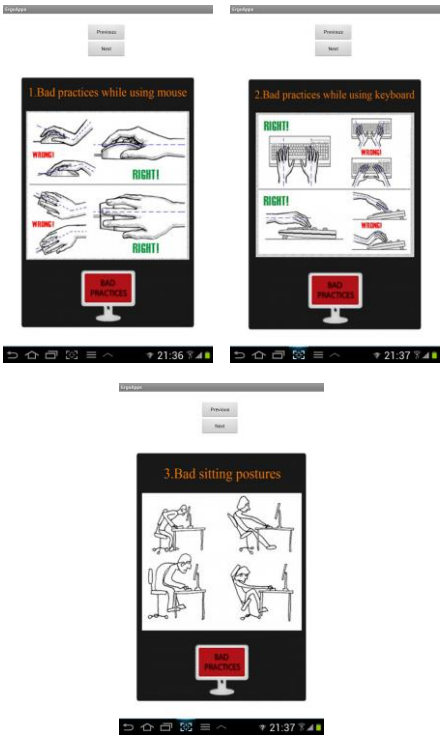


Figure 71 : Ergo Definition in 4 pages

- Under **Ergo Definition**, there will be four pages of simple information to convey the meaning of ergonomic in workplace and why it is important to all employees.

a) Ergonomic Info	
ii) Ergo Diseases  **Figure 72 : Ergo Diseases explanation in 4 pages**	- Under **Ergo Diseases**, there will be three pages of main WMSD diseases like back pain, carpal tunnel syndrome, and repetitive stress injury.
iii) Symptoms of Diseases  **Figure 73 : Ergo Diseases Symptoms video**	- Under **Symptoms of Diseases**, a short video will play together with a brief summary of the video. The video explains the potential causes and symptoms of having WMSD.

a) Ergonomic Info	
iv) Avoiding Ergo Diseases  **Figure 74 : Avoiding Ergo Diseases video**	- Under **Avoiding Ergo Diseases**, a short video will play together with a brief summary of the video. The video explains the importance of avoiding the complaint in order to prevent negative future effect like having ergonomic diseases.
v) Bad Ergo Practices  **Figure 75 : Bad Ergo Practices in 3 pages**	- Under **Bad Ergo Practices**, there will be three pages of conveying the bad practices in workplace like bad sitting posture, and bad ways of handling hand devices like mouse and keyboard.

a) Ergonomic Info

vi) Correct Ergo Practices

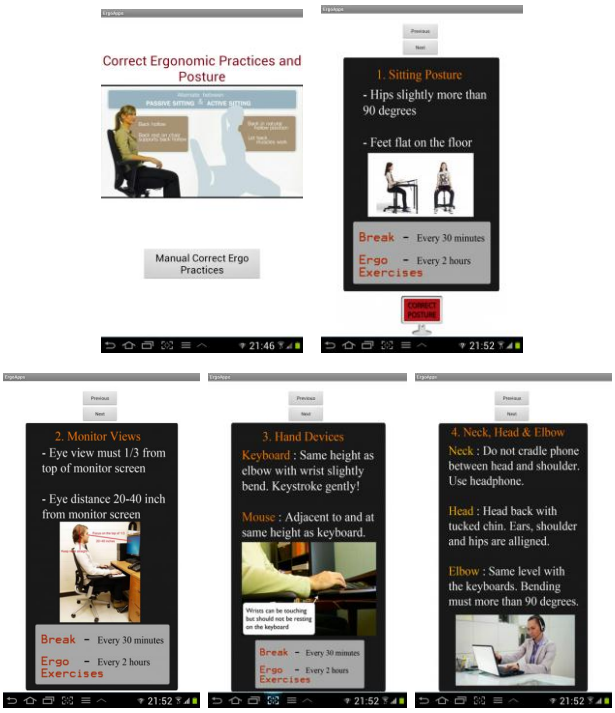


Figure 76 : Correct Ergo Practices video and manual guides.

- Under **Correct Ergo Practices**, there will be 2 parts. The first one will play a short video regarding the correct ergonomic practices and posture, and the second part consists of 4 pages manual guides on how to make sure having ergonomic practices and postures in workplace.

vii) Ergo Guidelines

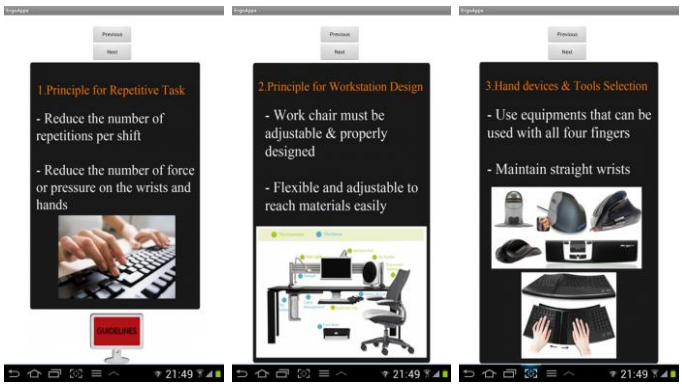


Figure 77 : Ergo Guidelines in 3 pages

- Under **Ergo Guidelines**, there will be three pages of conveying the guidelines proposed by DOSH, NIOSH & OSHA in enhancing the ergonomic environment in workplace. The guidelines consist of principle for repetitive task, workstation design, and how to select the best hand devices.

b) Ergo Exercise Videos

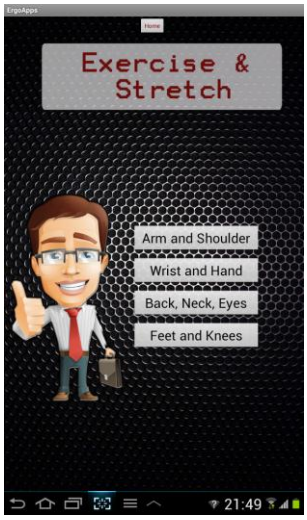


Figure 78 : Ergo Exercise Videos screen

- Under **Ergo Exercise Videos**, there are a few of videos and manual ergonomic exercises ranging from arm and shoulder, wrist and hand, back neck eyes, & feet and knees.

i) Arm and Shoulder

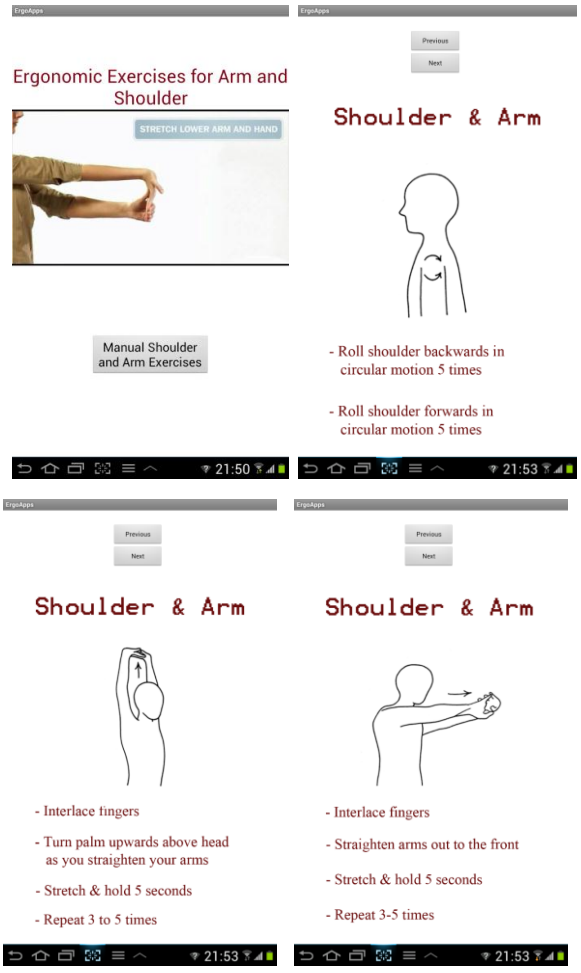


Figure 79 : Arm and Shoulder video and manual exercises

- Under **Arm and Shoulder**, there will be 2 parts. The first one will play a short video on how to practice arm and shoulder exercise. The second part is manual exercise that being demonstrated step by step.

b) Ergo Exercise Videos

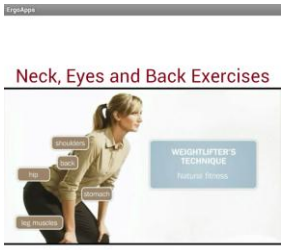
ii) Wrist and Hand

Figure 80 : Wrist and Hand manual exercises

- Under **Wrist and Hand**, it consists of 3 pages that demonstrated the step by step of how to practice simple ergonomic exercise related to wrist & hand.

b) Ergo Exercise Videos

iii) Back, Neck, Eyes



Manual Back Exercise

Manual Neck and Eyes Exercise

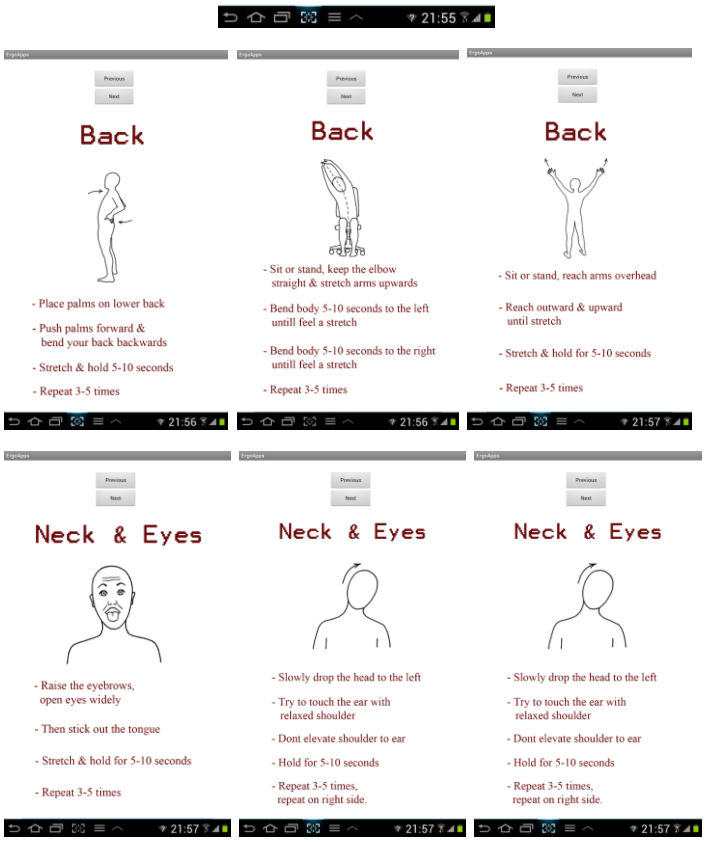


Figure 81 : Back, Neck, Eyes video and manual exercises

- Under **Back, Neck, Eyes**, there will be 2 parts. The first one will play a short video on how to practice back, neck, eyes exercise. The second part is manual exercise that being demonstrated step by step.

b) Ergo Exercise Videos

iv) Feet and Knees

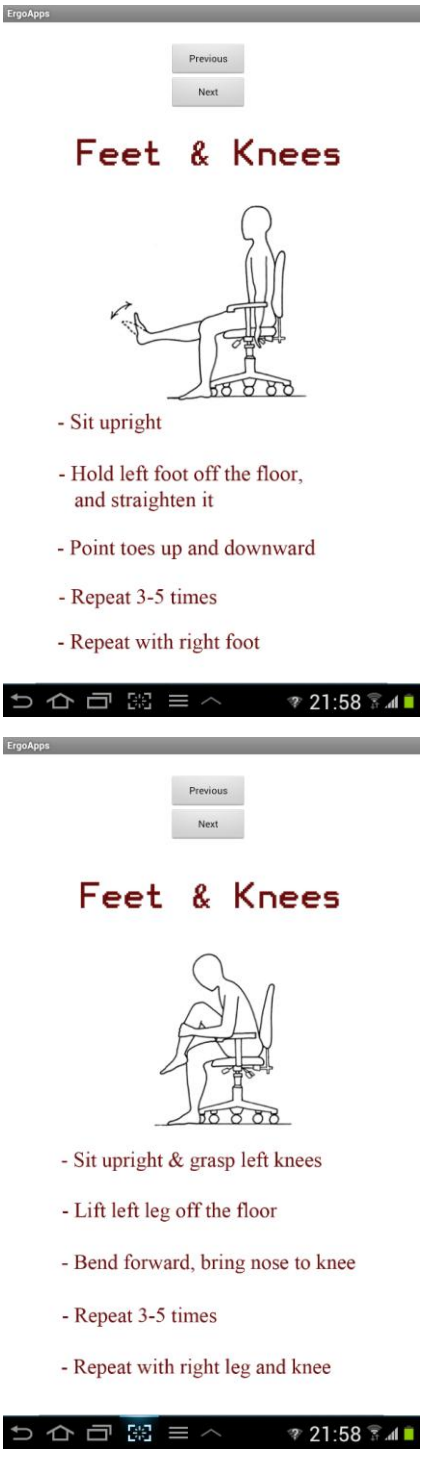
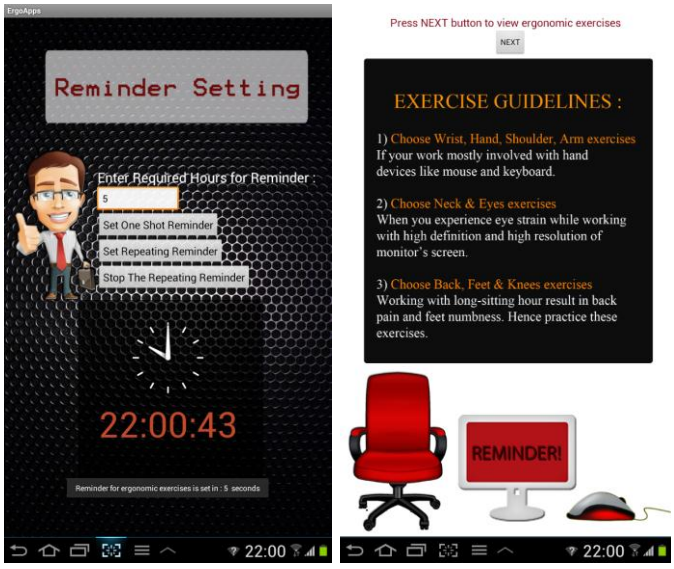


Figure 82 : Feet and Knees manual exercises

- Under **Feet and Knees**, it consists of 2 pages that demonstrated the step by step of how to practice simple ergonomic exercise related to feet & knees.

c) Reminder Setting

i) Set one shot reminder (Demo : 5 Sec)



ii) Set repeating reminder (Demo : Every 15 sec)

Figure 83 : Reminder Setting Pages

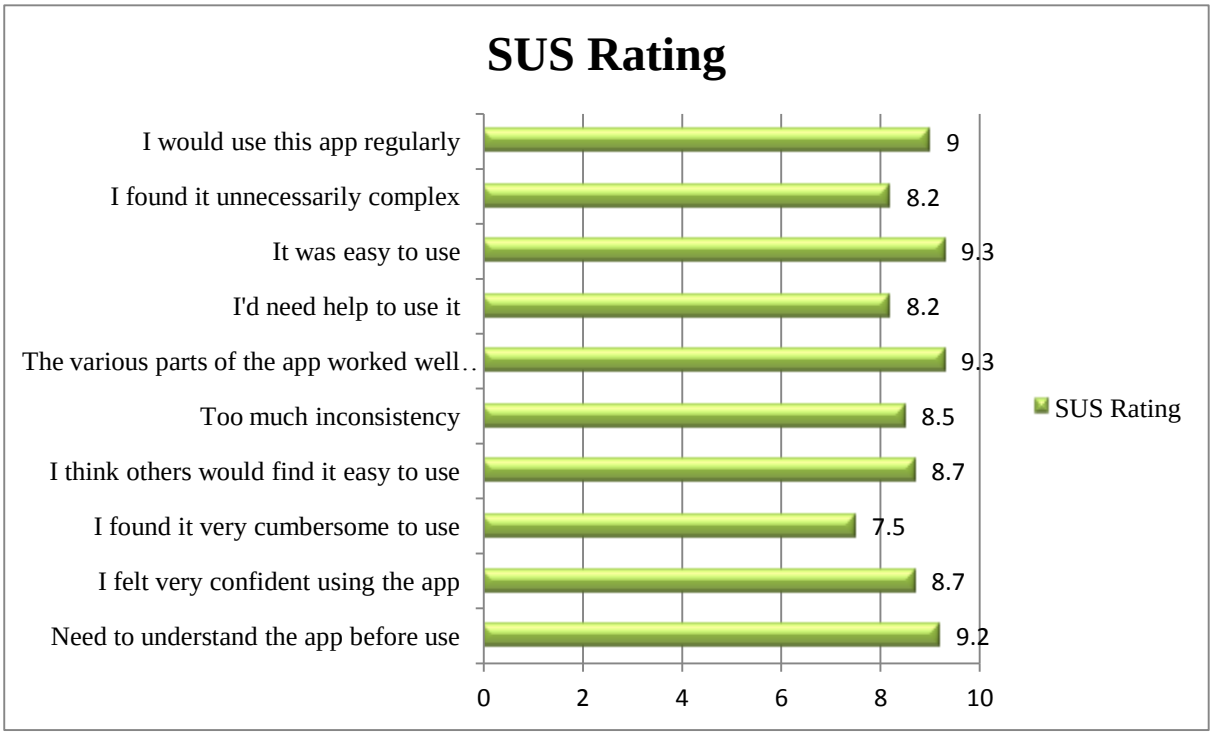
- Under **Reminder Setting**, it allows user to insert required hours to alert on having ergonomic exercises. The notification will keep notifying the users every 2 hours and will stop once user click **stop repeating reminder** button. Once the notification appears, it will redirect the user to the ergonomic exercises page.

4.4 FULL RESULT OF FINAL SYSTEM USABILITY SCALE (SUS)

4.4.1 The objective of SUS Evaluation

The objective of this SUS survey is to examine the capability of the ErgoApps application in term of effectiveness (can users successfully achieve their objectives), efficiency (how much effort and resource is expended in achieving those objectives), and satisfaction (was the experience satisfactory) while using the application. The main purpose of the application is to develop a mobile and reminder application that alert users on having ergonomic exercise in avoiding WMSD besides adhere to safe working practice. This survey also will focus on evaluating user perception towards the developed application, ErgoApps. (*Refer appendices for a set of SUS evaluation questionnaires.*)

4.4.2 Final Result of SUS Evaluation



SUS Average Score = 86.60

Based on above SUS result, the average score is very promising which are 86.60 from total score of 100. Since the respondents are from desk workers and staffs that highly involved with computer-related workload, they found that the application is very useful to be use daily during working time to enhance the efficiency and performance of their tasks. Besides that, the application also compliant with the rules embedded by DOSH, OSHA, and NIOSH in encouraging the employees to practice a safe working environment to avoid long-term negative effects in future.

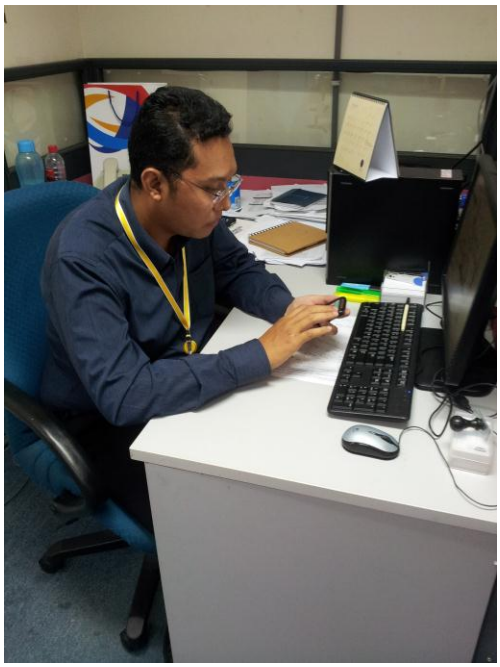


Figure 84 : Staff from UTP Admin Unit using the ErgoApp

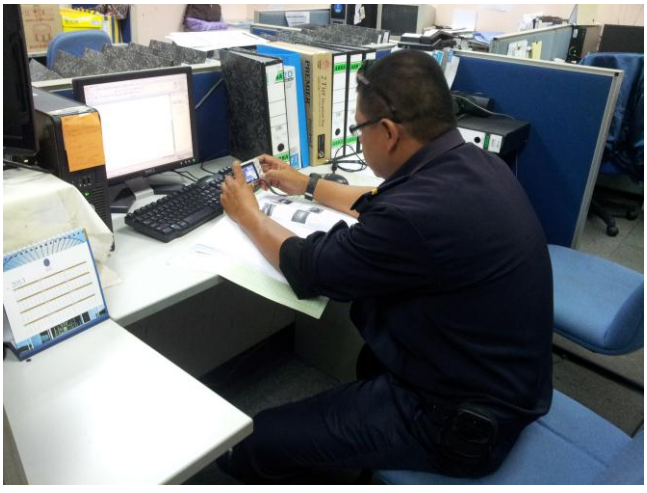


Figure 85 : Staff from UTP Security Department trying the ErgoApp

CHAPTER 5

CONCLUSION

There is no doubt that the ergonomic practice in workplace is vital in ensuring a better performance of human workforce besides ensuring their health, welfare and safety. To optimize human well-being and their overall task performance, preventing injuries and fatalities is just one of the many aspects of ergonomics. Since the discipline is new or maybe unknown, hence when we talk about ergonomic awareness most manufacturing and service industries may suffer. Another factor of lacking on ergonomic awareness were due to most small and medium industries had low capital and low budget constraints which disable them from hiring expertise or professional ergonomist to handle and ensure ergonomic improvements in their workplace. If compare to other injuries that due to sudden event like slip and fall, WMSD may worsen and more costly since it takes long time for employee back to work, resulting in higher medical and time loss payment (wages). In extra, hidden cost may exist when workers keep absent and slower in their work paces before they realized on WMSD's symptoms. Since the cost of designing an ergonomic workplace quite high and the medical cost in treating the diseases like WMSD keep increasing, hence with the implementation of this cost-effective mobile application is enable to create workers' awareness on the importance of it.

In addition, booming technology nowadays bring a new dimension to the society. With the rise of smart phones and Google's operating system Android, hence technology is influencing more people's life today more than ever before. Taking it as a granted, this is a great opportunity to inject the societies or workers specifically on the awareness of having a safe and ergonomic practice in the workspace that channeled via mobile Android application for the betterment of future and also parallel with the requirement and objective of OSHA and DOSH in ensuring occupants' health and safety but at the same time able to conduct the tasks successfully. System Usability Scale with the compromising average score of 86.60% out of 100% prove that the application is usable and practical to employees that always involved with high tense workload. Since the respondents are from desk

workers and staffs that highly involved with computer-related workload, they found that the application is very useful to be use daily during working time to enhance the efficiency and performance of their tasks.

To summarize on the ergonomic awareness in Malaysia, it is a fact that ergonomic play important role to enhance the performance and productivity of developed country together with compiling the rules and regulations from respective organization. In accordance of that, it is essentially costly to deal with all those kind of injuries and diseases especially WMSD. Besides, both direct cost and the loss of valuable service provided by the individual indirectly burden the management and employees themselves. Human workforces are an essential part of every business process and critical in delivering quality product and services. Therefore, ergonomic disease prevention must be taken seriously by applying ergonomics to office work that helps people work more effectively, efficiently, and productively at their jobs for example having simple ergonomic exercise every 2 hours gap to release stress and avoiding WMSD like being proposed under ErgoApps.

For the enhancement purpose, author would like to propose on having additional dynamic function like enable the users to have weekly reminder instead of daily reminder as being implemented on current product and enhance on the stretch videos where each ergonomic exercises are guided by the informative videos. With the implementation of cost-effective ergonomic mobile application like ErgoApps, it is compliant with the rules embedded by DOSH, OSHA, and NIOSH in encouraging the employees to practice a safe working environment to avoid long-term negative effects in future which may involves dreadful cost in treating WMSD.

REFERENCES

[01] Ali, A. Y., (2001) : Development of knowledge-based ergonomic software for the small and medium scale industries in Malaysia. Malaysian Ergonomics.

[02] Andrew A. Dahl, MD, FACS (2008) : *MedicineNet* [Online] [Cited: November 16, 2012] http://www.medicinenet.com/eye_strain/article.htm

[03] Armstrong, T. J. (1986). Ergonomics and cumulative trauma disorders. Hand Clinics 2(3):553-565

[04] Back pain at work: *Preventing pain and injury*. [Online] MayoClinic, 2010. [Cited: October 08, 2012] http://www.mayoclinic.com/health/back-pain/HQ00955.

[05] Bellandi, T. (2010): *Federation of European Ergonomics Societies (FEES).* Dortmund,Germany.

[06] Bush, P.M. (2012): *Ergonomic Foundational Principles, Applications, and Technologies.* Boca Raton, CRC Press Taylor & Francis Group.

[07] Carpal Tunnel Syndrome – *Symptoms* [Online] NHS CHOICES, 2010. [Cited: October 16, 2012] http://www.nhs.uk/Conditions/Carpal-tunnel-syndrome/Pages/Symptoms.aspx

[08] Eclipse – Free Software (2012) : [Online] *Wikipedia Eclipse* [Cited: December 05, 2012] http://en.wikipedia.org/wiki/Eclipse_(software)

[09] Ergonomics-Info.com – *Guidelines for a healthier and safer workplace*. [Online] Ergonomics-Info.com, 2010. [Cited: October 06, 2012] http://www.ergonomics-info.com/why-is-ergonomics-important.html

[10] Gary, H. (2011) : [Online] *All About Vision* [Cited: November 16, 2012] http://www.allaboutvision.com/cvs/irritated.htm

[11] Guo, H., S. Tanaka, et al. (1995). Back pain among workers in the United States: National estimates and workers at risk. Am. J. Indus. Med. 28:591-602.

[12] Government of Alberta – *Office Ergonomics: Key to Health and Safety in the Workplace.* [Online] Healthy Places, 2012. [Cited: October 06, 2012] http://www.healthyalberta.com/HealthyPlaces/621.htm

[13] Harris, D., Duffy, V, Smith, M., And Stephanidis, C. (2003): *Human -Centred Computing ; Cognitive, Social and Ergonomic Aspects* . New Jersey, Lawrence Erlbaum Associates,Inc.

[14] Jingst, A., (2010): *Principle consultant for Safety or Ergonomics Consulting* Anytown, Illinoise.

[15] Kelsey, J. (1982) Epidemiology of musculoskeletal disorders. NY. Oxford University Press

[16] Loo, H.S., P.H.P. Yeow, (2007). Ergonomics intervention in the manufacturing of air handler coil assembly. Proceedings of the International Conference on Ergonomics, Dec. 3-5, Hotel Istana, Kuala Lumpur, Malaysia, pp: 324-328.

[17]MIOSH Net: *Establishing an ergonomics program for industry* [Online] MIOSH, 2010. [Cited: February 05, 2013] http://miosh.net/articles/

[18] Mustafa, S. A., S. Kamaruddin, Z. Othman., and Mokhtar, M., (2009) : Ergonomics awareness and identifying frequently used ergonomics programs in manufacturing industries using quality function deployment. Am. J. Sci. Res., 3: 51-66.

[19] O'Neill, D.H., 2000. Ergonomics in industrially developing countries: Does its application differ from that in industrially advanced countries? Applied Ergon., 31: 631-640. DOI: 10.1016/S0003-6870(00)00033-8

[20] OSHA European: *Ergonomic Case Study* [Online] OSHA, 2010. [Cited: October 07, 2012] http:// www.cdc.gov/niosh/about.html

[21] OSHA European: *Ergonomic in Workplace* [Online] OSHA, 1987. [Cited: October 07,2012] http://www.ergoweb.com/resources/casestudies

[22] Pascarelli, E., and Quilter, D., (1994): Repetitive Strain Injury: *A Computer User's Guide.* John Wiley & Son's, Inc.

[23] Pencil History. (2010). http://www.pencils.com/pencil-history

[24] Physical Therapy Corner: Office Ergonomics – *A guide to a Healthier, More Productive and Happier Work Environment.* [Online] NISMAT, 2009. [Cited: October 05, 2012] http://www.nismat.org/ptcor/ergo

[25] P. Shukor, A., (2010) : [Online] *Workplace Ergonomic Course* [Cited: February 05, 2013] http://profshukor.blogspot.com/2009/09/workplace-ergonomics-course.html

[26] Ramachandra, T., (2011) : [Online] *Bharatanatyam-eye-exercises*[Cited: November 30, 2012] http://www.gurus247.com/blog/bharatanatyam-eye-exercises/

[27] Richardson, S., M.L. Wong and S. Pataraparich, (1986).Sex and managerial stress: A Singapore study. Proceedings 23rd Annual Conference of Industrial Ergonomics Society of Australia and New Zealand, Nov. 25-28, Perth, WA., pp: 161-169.

[28] Taylor, F.W. (1911). The Principles of Scientific Management, Harper Bros: New York.

[29] University of Wisconsin-La Crosse (2012) : [Online] *Importance of having exercise* [Cited: November 28, 2012] http://www.uwlax.edu/ehs/Ergonomics_Carpal_Tunnel.htm

[30] Washington State Department of Labour and Industries: *Office Ergonomics, Practical Solutions for a safer workplace.* [Online] WISHA, 2002. [Cited: October 08, 2012] http:// www.LNI.wa.gov/wisha/ergo/.

[31] *Wikipedia - Back Pain*. (n.d.). Retrieved 4 3, 2012, from Wikipedia: http://en.wikipedia.org/wiki/Back_pain

[32] Work Related Syndrome: *Carpal Tunnel Syndrome* [Online] Irwin Mitchell LLP, 2012. [Cited: October 15, 2012] http://www.irwinmitchell.com/servicesforyou/personal-injury-claims/atoz/workrelated/carpaltunnel/Pages/default.aspx

[33] Work Related Musculoskeletal Disorders (WMSD's) – *Tendonitis* [Online] CCOHS, 2005. [Cited: October 17, 2012] http://www.ccohs.ca/oshanswers/diseases/rmirsi.html

[34] Yeow, P.H.P. and R.N. Sen, (2002). The promoters of ergonomics in industrially developing countries, their work and challenges. Proceedings of the 3rd International Cyberspace Conference on Ergonomics, (ICCE' 02), The International Ergonomics, Johannesburg S.A., pp: 18-30.

APPENDICESS

1) **Questionnaires to DOSH officer**

Ergonomic hazards in the workplace: Assessment and prevention

Of Repetitive Stress Injuries (RSI) and Musculoskeletal Disorders

Preview of Problem Statement: In relation to ergonomic, safety is one of the main elements that widely discuss especially in Health and Safety Environment (HSE). To optimize human well-being and their overall task performance, preventing injuries and fatalities is just one of the many aspects of ergonomics. Under this research, it will focus more on the first domain of ergonomic which is **physical ergonomic** that encourage workers to practice ergonomic working environment involving correct working posture, devices handling, combined with workplace layout and design. By practicing respective assessment, severe ergonomic disorder can be minimized like avoiding back pain, minimizing repetitive motions (Repetitive Stress Injuries), and facilitating a practice to prevent musculoskeletal disorders for example Carpal Tunnel Syndrome.

Objective: This interview is conducted in objective of studying factors that lead to involvements of workers in practicing ergonomic working environment in preventing musculoskeletal disorders and Repetitive Stress Injuries. The result of these studies will be analysed and few solutions will be suggested to inhibit ergonomic severe diseases as mention before via awareness channelled using Android application. Thank you for all contributions, I hope that this survey will help in producing safer working space.

Questionnaire to DOSH officer:

1) From DOSH view, what can defined Ergonomic working environment?

2) In Ipoh or Malaysia, what steps taken by DOSH to hinder the risk or ergonomic diseases amongst employees?

3) What is the example of the steps taken?
(*Is it involving Physical Ergonomic like handling input devices, chairs, and working*)

4) Is there any act and regulations declared by DOSH Malaysia that related to Ergonomic working environment?

5) Briefly discuss on the statistic of ergonomic diseases faced by Malaysian employee or in Ipoh specifically
(Ex: *Musculoskeletal syndrome and Repetitive Stress Injuries, etc*)

6) From the statistic, what is major Ergonomic issue faced by them?
(Ex: *Bad chair, bad mouse design, repetitive work, lifting over-weighted items, etc*)

7) Did you agree that a good and conducive working environment impact the productivity of respective firm? Does Ergonomic practices involved in making sure the optimal productivity?

8) Approximately how much and what incur a big loss to the firm that relate to safety practice in working space / environment?
(Ex: *Medical compensation, lawsuit, etc*)

9) How does DOSH educate employer and employee on the importance of practicing Ergonomic working environment? Is it solely depends on the regulations and act?

10) I am currently doing research and developing an Android Application that stressed on the importance of Ergonomic practice in working environment. Is there any suggestion and crucial element that should be included?